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in this issue

Page

Supply Functions for Cotton in Imperial Valley, California..........*Gerald W. Dean, Stanley S. Johnson, and Harold O. Carter* 1

A Polyperiod Model for Estimating the Supply of Milk.........*Keith G. Cowling and C. B. Baker* 15

A Reformulation of Certain Structure and Conduct Attributes of Pure Competition... *Norman Townshend-Zellner* 24

Book Reviews......................*Henry A. Wallace, Allen B. Paul, Ernest W. Grove, John M. Brewster, and Ronald L. Mighell* 30

UNITED STATES DEPARTMENT OF AGRICULTURE Economic Research Service

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(Continued on page 40.)

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Supply Functions for Cotton in Imperial Valley, California

By Gerald W. Dean, Stanley S. Johnson, and Harold O. Carter

This article reports the results of an analysis of cotton supply response for Imperial Valley, California, one of the two distinct cotton growing areas in the State. Ultimately, these results for the Imperial Valley can be combined with similar studies now in progress throughout the United States to form a comprehensive picture of cotton supply response. However, the two more immediate objectives of the paper are: (1) To provide empirical estimates of the supply of cotton which would be forthcoming from the Imperial Valley at various prices, both in the short and the long run; and (2) to indicate the methodology used in handling certain problems commonly faced by supply analysts, in the hope that these procedures will prove directly applicable or suggestive of possible alternatives in other empirical situations. Two unique additions to the linear programming methodology are illustrated in this study. The first is the use of Markov chains to project changes in the farm size distribution to 1975. The second is an adjustment of the cotton supply function for associated changes in the price and production of winter lettuce, a major competing crop. This is Giannini Foundation Paper No. 231. The authors gratefully acknowledge the contribution of William R. Burton, research assistant at California, who assisted in much of the basic empirical analysis.

CALIFORNIA has produced about 13 percent of the United States cotton crop in recent years. There was a sharp upward trend in the share of cotton produced in California and other parts of the Southwest prior to allotments in 1954. With a relaxation of controls perhaps this trend would resume, resulting in a larger concentration of cotton production in the West.

The United States Department of Agriculture has initiated a series of State and regional studies in the major cotton areas of the United States, with particular emphasis on this question of interregional advantage in cotton production.[1] In these studies, an indication of competitive advantage is obtained by estimating cotton supply functions for typical farms in various regions, showing how farmers might expand or contract cotton production in response to changes in prices. Given an appropriate weighting system, these individual farm results also can be aggregated to construct regional and national supply functions for cotton. Taken in conjunction with demand, these supply functions should prove useful in determining the equilibrium price of cotton without controls, and concurrently, the relative importance of various types of farms and geographic areas in cotton production.

General Concepts

Imperial Valley accounts for only about 60,000 acres (7 percent) and 145,000 bales (7 percent) of the cotton production in California. Yet this area of about 500,000 irrigated acres has considerable possibility for expansion in cotton production. It has ample low-cost water, productive soils, favorable climatic conditions, and a predominance of large, well-managed farms. While historically not a large cotton producing area, as reflected in its relatively low acreage allotments, it would appear to be potentially one of the more responsive areas in the West to relaxation of cotton controls.

Supply functions for this area have been derived by the aggregation of individual farm supply responses. Supply analysts are well aware that this is only one possible approach to supply analysis. Its advantages and disadvantages relative to time series analysis, interregional competition models, and other methods have been discussed in some detail elsewhere.[2] Rather than advocating the individual firm aggregation approach over alternative methods, we note only that results from all methods of analysis appear to be complementary and, taken together, should provide a more comprehensive understanding of supply phenomena.

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[1] The work is being coordinated through Western Regional Project W–54 and Southern Regional Project S–42.

[2] See Nerlove, Marc, and Bachman, Kenneth L., "The Analysis of Changes in Agricultural Supply: Problems and Approaches," *Journal of Farm Economics*, Vol. 42, No. 3, August 1960, pp. 531–554; and Heady, E. O., *et al.*, ed. *Agricultural Supply Functions*, Ames: Iowa State University Press, 1961.

The steps taken in this study generally follow those outlined by Johnson:[3]

> 1. Securing an appropriate set of input-output coefficients.
> 2. Devising a method of determining which resource flows can and cannot be varied.
> 3. Selecting a range over which variation in product price will be considered.
> 4. Computing optimum outputs (in terms of a selected set of norms) as a function (discrete or continuous) of product price.
> 5. Repeating steps 1 to 4 for different situations within the industry.
> 6. Aggregating results from steps 1 to 5 into an estimate of how output for the industry depends on price.
> 7. Adjusting the results obtained in 6 for their shortcomings as *partial equilibrium* estimates, for example, for the influence which expanded use of an input may have on its price and, hence, on marginal costs and on the ability of the industry to expand production. . . .

Our previous statement of objectives implies that we are primarily interested in supply functions which are "predictive" (what farmers *would* do) rather than "normative" (what farmers *should* do relative to some norm such as profit maximization). However, our individual farm programming and budgeting solutions are of the normative type in that they show farm organizations and output patterns which maximize profits at different prices, given certain technical and institutional restrictions. The length of run or time period for adjustment then becomes critical in interpreting the results. In the short run, the normative solutions probably constitute an unsatisfactory predictive device. As the adjustment period lengthens, however, the normative and predictive solutions should tend to converge. Our major emphasis, therefore, is on the longer run, defined as approximately 1975.

TABLE 1.—*Assumptions underlying development of normative cotton supply functions for two lengths of run*

Item	Short run	Long run
1. Approximate time period for response.	immediate (1960)	15 years (1975)
2. Level of technology and yields.	current (1960)	advanced (1975)
3. Size distribution of farms	current (1960)	predicted (1975)
4. Machinery	fixed	variable
5. Land per farm	fixed	fixed
6. Total land in farms producing cotton (acres).	350, 000	450, 000
7. Price index of labor (1960=100).	100	125
8. Price of alternative crops	current	current and ±30%
9. Price of cotton	variable	variable
10. Government controls of cotton.	none	none

Detailed Empirical Procedures

Table 1 summarizes the major assumptions involved in deriving the short- and long-run normative supply functions for the Imperial Valley. The rationale underlying these assumptions and the empirical procedures employed in implementing them are outlined in the following sections.

Selection of "Typical" Farm Situations

A nearly complete list of growers in the Imperial Valley, showing acreages in individual crops and total acreage per farm, was stratified into two types of farms: (1) *Field crop farms*—farms growing only field crops, and (2) *vegetable crop farms*—farms growing a combination of field crops and vegetables. A stratified sample with four acreage size categories (0–320, 320–640, 640–1,200, and > 1,200) was drawn from each list, and fairly complete schedules were taken by personal interview regarding the organization and inputs for about 10 farms in each size and type category—approximately 80 farms in all. The information obtained provided detailed data on farm organization, machinery, labor, yields, costs, leases, and so on.[4] The survey information was essential in developing restrictions and activities for individual farm budgeting and programming. However, no attempt was made to obtain detailed costs by enterprises from farm survey data; these were synthesized from engineering data and previous enterprise cost studies. A 10 percent sample of cotton growers drawn from County Agricultural Stabilization and Conservation records revealed a close correspondence with the above sample on farm size distribution, cotton acreage, and total acreage per farm.

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[3] Johnson, Glenn L., "Budgeting and Engineering Analysis of Normative Supply Functions," in Heady, *et al.*, *op. cit.*, pp. 171–172.

[4] For detailed description of the characteristics of these farms, see Carter, H. O. and Dean, G. W., *Cost-Size Relationships for Cash-Crop Farms in Imperial Valley, California*, Giannini Research Report No. 253, May 1962.

From the above samples and 1960 Census data it was estimated that, of the approximately 500,000 acres of irrigated cropland in Imperial Valley, about 350,000 acres were in farms growing cotton. Of this, about 250,000 acres were in field crop farms and 100,000 acres in vegetable crop farms. The remaining 150,000 acres in the valley were in field crop and vegetable farms not growing cotton. This information also revealed that approximately 75 percent of the farms were owned and 25 percent rented. Based on size, tenure, and type of farm, 11 different "typical" or "representative" farm situations were selected. Programming and budgeting of these situations provide the individual farm supply functions which become the components for later aggregation.

Level of Technology, Wages, Yields, and Prices

For the short run, current technology, prices, and yields were used; for the long run, changes in these variables were projected to 1975. Wages were increased by 25 percent to reflect the probable pressure for higher farm wages in California. Wages of skilled labor (tractor drivers) were assumed to increase from $1.60 to $2.00 per hour by 1975, and wages of unskilled labor from $0.80 to $1.00 per hour. These increases may well prove to be overly conservative, particularly if the Mexican national program is discontinued and the economy operates at near full employment. With higher wages, labor-saving technology such as mechanical harvesting of cotton, mechanical thinning of sugar beets, and flame cultivation would be economical and hence were assumed to be adopted for 1975.

Crop yields also were projected for 1975 based on the informed judgment of crop specialists.[5] Resource prices other than labor were held constant at an average of recent levels for both the short- and long-run analyses. The supply functions derived initially show the response of cotton production to changes in cotton prices, all other product prices held constant at recent levels. However, cotton response in the long run also is examined when other product prices vary ±30 percent. A special problem with vegetable prices also is examined.

Fixity of Resources

Presumably, more factors become variable as the length of run increases. Hence, in the short run, both machinery and land per farm are fixed, while, in the long run, machinery becomes variable. When machinery is a variable factor, depreciation and interest are entered as variable costs in each crop activity. The method used assumes that machinery depreciation, interest, and repairs are a function only of use, hence, these costs are allocated to individual crops on an hours-of-use basis. But differences in length of life are assumed between farm sizes, incorporating in essence a greater obsolescence factor into machinery costs on smaller farms with less annual machinery use. Hence, with respect to machinery costs, there are constant unit costs *within* farm size groups but decreasing unit costs between size groups. Land per farm is held constant for both lengths of run. That is, the acreage per "typical" farm is the same in both cases and land buying, renting, or selling activities are not included. However, the *number* of farms in each size group is assumed to change over time, and these changes are "predicted" using Markov Chains (see next section). Furthermore, the total land available for cotton production in Imperial Valley is assumed to increase over time, not because of a net increase in total irrigated acreage (for example, reclamation of desert land), but because without allotments cotton would be a relevant alternative on an increasingly large proportion of valley land. The projected 1975 acreage for cotton farms, determined primarily by soils adapted to cotton production, totals about 450,000 acres. Present acreage in cotton farms is restricted to 350,000 acres primarily because these are the farms which have historic allotments sufficiently large to warrant planting.

Distribution of Farm Size—Markov Chains

The size distribution of farms has changed

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[5] Detailed estimates are given in: Dean, G. W., and McCorkle, C. O., Jr., *Projections Relating to California Agriculture in 1975*, Calif. Agr. Exp. Sta. Bul. 778.

TABLE 2.—*Markov chain computations of changes in farm size distribution, Imperial Valley, California*

Part A. Actual and predicted number of farms, by acreage size group [1]

Year	Size Groups (acres per farm)						
	1-99	100–219	220–499	500–999	>1,000	Total farms in business	Farms out of business since 1950
	Actual distribution						
1950	1, 178	362	306	177	108	2, 131	
1955	836	274	241	159	123	1, 633	498
1960	603	218	208	155	122	1, 306	825
	Predicted Distribution						
1955 [2]	841	280	253	165	115	1, 654	477
	(5)	(6)	(12)	(6)	(−8)	(21)	(−21)
1960 [2]	601	217	209	155	122	1, 304	827
	(−2)	(−1)	(1)	(0)	(0)	(−2)	(2)
1965	429	168	173	145	128	1, 043	1, 088
1970	306	130	144	135	134	849	1, 282
1975	219	101	120	127	140	707	1, 424

Part B. Number of estimated transitions among size groups 1950–55, 1955–60 and total [3]

Size group	Size Groups					
	— (0)	1–99 A. (1)	100–219 A. (2)	220–499 A. (3)	500–999 A. (4)	>1,000 A. (5)
(0)	100, 000 [4]	0	0	0	0	0
(1)	342	836	0	0	0	0
	233	603	0	0	0	0
	575	1, 439	0	0	0	0
(2)	88	0	274	0	0	0
	56	0	218	0	0	0
	144	0	492	0	0	0
(3)	68	0	0	238	0	0
	38	0	0	203	0	0
	106	0	0	441	0	0
(4)	0	0	0	3	159	15
	0	0	0	5	154	0
	0	0	0	8	313	15
(5)	0	0	0	0	0	108
	0	0	0	0	1	122
	0	0	0	0	1	230

TABLE 2.—*Markov chain computations of changes in farm size distribution, Imperial Valley, California*—Continued

Part C. Transition probability matrix P.[5]

Size Group

$$\begin{array}{c|cccccc|}
 & (0) & (1) & (2) & (3) & (4) & (5) \\
(0) & 1 & 0 & 0 & 0 & 0 & 0 \\
(1) & 0.286 & 0.714 & 0 & 0 & 0 & 0 \\
(2) & 0.226 & 0 & 0.774 & 0 & 0 & 0 \\
(3) & 0.194 & 0 & 0 & 0.806 & 0 & 0 \\
(4) & 0 & 0 & 0 & 0.024 & 0.932 & 0.044 \\
(5) & 0 & 0 & 0 & 0 & 0.004 & 0.996
\end{array} = P$$

[1] Actual distribution from Census of Agriculture; predicted distribution from Markov Chain computations.
[2] Numbers in parentheses indicate deviation of "predicted" from actual.
[3] Upper, center, and lower numbers in each cell refer to transitions of 1950–55, 55–60, and total, respectively.
[4] Arbitrary number representing potential entrants into industry. Other numbers in this column represent firms leaving active status in industry (for example, going out of business). See Adelman, op. cit. p. 10.
[5] From Part B of table 2.

substantially in Imperial Valley since World War II. Part A of table 2 indicates the sharp drop in total number of farms and the relative increasing importance of large farms in the past decade. Further evidence of this concentration is shown by the fact that the proportion of land operated by farms of over 500 acres increased from 42 percent to 74 percent from 1945 to 1960.

Past research work indicates substantial economies of scale in Imperial Valley field crop farms until size increases to about 1,500 acres.[6] Size of farm was one of the major characteristics used in differentiating "typical" farming situations. This procedure was justified by the later programming analyses which indicated that the responses of farms differed considerably by size.

Because response differed substantially by size group, and because farm size distribution has changed rapidly recently, it appeared important to consider carefully the question of projecting the farm size distribution to 1975. One method would be simply to extrapolate past trends in each size group. A more appealing method is suggested by Adelman, Collins and Preston, Judge and Swanson, and others[7] in using Markov Chains to estimate size distributions. The critical step in this method is the construction of a transition probability matrix (P) whose elements denote the probability of each firm moving from size i to size j in a single time period. The probability of each firm moving from size i to j in n time periods is found by multiplying the transition matrix by itself n times, yielding a new matrix P^n. The predicted size distribution in the nth time period (w^n) is obtained by multiplying the initial firm size distribution by this transition matrix to the nth power, i.e., $w^n = w^o P^n$.

As stated by Judge and Swanson,[8] the major assumption underlying this method is that changes over time "can be regarded as a stochastic process, with probabilities of transition constant in time and the probability of moving from one state to another a function only of the two states involved." In effect, the method assumes that factors operating during the period of observation will continue to act in the same way in the future. Unfortunately, this simplifying assumption also is common to other projection procedures.

The data required to estimate the transition matrix are extensive and seldom readily available. Ideally, records of the actual size transitions of a large number of firms over a fairly long time period are needed. Since these data were not available in Imperial Valley, the aggregate figures on farm size distribution reported at 5-year intervals by the Census were used (see Part A, table 2). In lieu of data on how *individual* firms changed in size through time to form the aggregate changes, we hypothesize that these movements closely correspond to the following rule:

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[6] See Carter and Dean, *op. cit.*

[7] Adelman, I. G., "A Stochastic Analysis of the Size Distribution of Firms," *Journal of the American Statistical Association*, 53: 893–904, December 1958; Collins, N. R., and Preston, Lee E., "The Size Structure of the Largest Industrial Firms, 1900–1958," *The American Economic Review*, Vol. LI., No. 5, December 1961; Judge, G. G., and Swanson, E. R., "Markov Chains: Basic Concepts and Suggested Uses in Agricultural Economics," *Illinois Exp. Sta. Res. Rept.* AERR–49, December 1961. These are only a few of the relevant references. They lead to a large body of literature on the subject.

[8] Ibid.

"Firms in the larger two size categories either remain in the same size category, or move up or down one category over each five-year period. Firms in the smaller size groups 1, 2, and 3 either remain in the same category, move up one category or go out of business (lose their identity by being absorbed by another firm)."

This hypothesis is based on evidence that farms in the larger two size categories are more efficient (obtain lower costs per acre or unit of output) than smaller farms.[9] Essentially, the hypothesis reflects an "up or out" philosophy: Small farms will be forced to become larger and more efficient, or go out of business. The data in the top portion of Part A, table 2, are consistent with this hypothesis, showing a sharp decrease in numbers of farms in the three small size categories, a less drastic decrease in the 500–999 acre category and an increase in farms of over 1,000 acres.

The working of this hypothesis can be illustrated with reference to the changes in farm size between 1950 and 1955 in table 2. Part A, table 2 shows that the number of farms in size group 5 (>1,000 acres) increased from 108 to 123 from 1950 to 1955. Part B, table 2 hypothesizes that the 123 farms in size group 5 in 1955 resulted from the 108 firms already in that group in 1950 *staying* in that group and 15 farms moving up to group 5 from group 4.[10] The 159 farms in size group 4 in 1955 were hypothesized to result from 159 of the 177 farms in that size group in 1950 staying in that group. Thus, of the 177 farms in size group 4 in 1950, 159 were assumed to stay in group 4; 15 went to group 5; and 3 went to group 3. Continuing this allocation, of the 306 farms in size group 3 in 1950, 238 stayed in group 3 and 68 went out of business (to category 0). Similar allocations are made for the remaining size groups. Corresponding transitions are traced out for the 1955–60 period and added to those of 1950–55 to obtain the total numbers of transitions.

From these data, the transition probability matrix P (Part C, table 2) is computed, showing the probability of a firm in size group i moving to size group j over a 5-year period (the sum of probabilities in each row = 1). The matrix P is then raised to successive powers and premultiplied by the 1950 actual (initial) size distribution to project distributions for 1955, 1960, 1965, 1970 and 1975 (bottom portion, Part A, table 2). The "predicted" distributions of 1955 and 1960 can be compared with the actual distributions in those years. While these "predictions" are close, particularly so in 1960, it is apparent that this is analogous to "testing" a regression equation against the data from which it was derived.

As yet, no statistical tests of the reliability of these or any other projections for the future, have been developed, but the distributions projected by this analysis intuitively appear quite reasonable. The 1975 projections indicate a substantial increase in number of large farms (>1,000 acres), a slight decline in farms of 500–999 acres and sharp decreases in numbers of smaller farms. The total number of farms in business is projected to drop from 1,306 in 1960 to 707 in 1975. While this may appear to be a drastic reduction (a loss of 599 firms in 15 years) it should be noted that the number of firms dropped from 2,131 to 1,306 from 1950 to 1960—a loss of 825 firms in only 10 years. Our projections reflect the diminishing rate at which firms have been going out of business and/or merging with other firms in Imperial Valley since World War II.

Two supplementary remarks on the above use of Markov Chains may be of interest: (1) Slightly different hypotheses as to how firms changed size groups led to very little change in predicted size distributions for 1975. One such hypothesis was an "up or out" rule for all farm sizes, rather than for just the smallest three size groups; another hypothesis was that, for the three smallest sizes of firms, a reduction in number of firms in those groups was accomplished by half going out of business and half moving to the next smallest size group. (2) The Markov transition matrix used above for projection to 1975, if further extended, would lead to the illogical result that, when the industry reaches its equilibrium state, all farms would be out of business. This is due to the "regular" way in which the transition hypothesis operates; it also suggests that the direction of bias by 1975 probably is toward overestimating the number of firms going out of business.

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[9] Carter and Dean, *op. cit.*

[10] Let t_{ij} represent the cell entries in Part B, table 2, where i = row and j = column. Then t_{ij} represents the number of firms moving from size group i to size group j in one 5-year Census period. The upper, center and lower numbers in each cell refer to transitions of 1950–55, 1955–60, and total respectively.

Empirical Supply Functions

The empirical results will be presented as follows: First, supply functions for several representative individual farm situations are presented and interpreted. Second, supply functions aggregated for the Imperial Valley for the short and long run are presented. Third, shifts in the supply function caused by changes in prices of competing crops are examined. Finally, a method for adjusting the supply function for one of its defects as a partial equilibrium solution is presented.

Individual Farm Supply Relationships

As examples, four short-run individual farm supply functions for cotton are shown in figure 1. Note that the functions for vegetable crop farms consist of several "steps," while the field crop farms are simple right-angle functions. The functions for vegetable crop farms contain steps because several vegetable crops compete favorably with cotton over a wide range of cotton prices. Cotton successively outcompetes these vegetable crops as the cotton price is raised. Among field crop farms, however, sugar beets and alfalfa rank, in that order, as the highest income crops aside from cotton. At extremely low cotton prices, the maximum sugar beet acreage allotment is planted and the remainder of the farm is most profitably planted to alfalfa.

As the cotton price is increased enough for cotton to outcompete alfalfa (at 21–23 cents in figure 1), 50 percent of the farm is planted to cotton. The stipulation that no more than 50 percent of the land may produce cotton is based on the advice of agronomists, soil scientists, and farmers that greater acreage on a continuing basis would probably result in disease and salinity problems. Unfortunately, there is not general agreement on this critical restriction; for example, a few farmers in the area have grown cotton continuously on the same soil for over 10 years with constantly increasing yields.

This problem is symbolic of a difficulty encountered in other large-scale farming areas in California—namely, to establish meaningful restrictions for linear programming and budgeting analyses. On examination, almost every major farm resource employed in the Imperial Valley appears to be "variable." To be sure, land per farm is relatively fixed in the short run, though renting is common and changes in farm size distribution indicate substantial flexibility in size in the longer run. On the other hand, contract machinery services and labor are readily available and can be (and are) hired seasonally throughout the year. Furthermore, water in Imperial Valley is relatively inexpensive and in relatively large supply.[11]

Thus, the primary restrictions (in addition to land), are limitations of individual crop acreages and combinations because of disease, rotational problems such as double cropping, government acreage restrictions on some crops, and risk limitations on vegetable crops. As a result, most of the farm problems analyzed are, from a mathematical point of view, simple enough to solve by budgeting or simplified programming procedures.

Because of the limited number of restrictions, small changes in price lead to substantial acreage changes in the individual farm programs of figure 1. We would argue that the critical point here is to define a sufficiently large number of representative situations to truly describe the population of farms. Rather simple results for a large number of carefully defined situations would appear to provide a more reliable basis for deriving aggregate supply functions than extremely complex programs for a few crudely defined "composite" farms.[12]

Aggregate Supply Functions for Different Lengths of Run

Figure 2 shows the supply functions for the Imperial Valley resulting from the aggregation of the eleven different typical farm situations. These aggregates were derived by multiplying the outputs per typical farm by the projected number of farms in the respective size groups.[13] The aggre-

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[11] However, water supply constitutes an important restriction in parts of the San Joaquin Valley—California's major cotton area.

[12] This point also is implied in: McKee, Dean E., and Loftsgard, Laurel D., "Programming Intra-Farm Normative Supply Functions." In Heady *et al.*, editors, *Agricultural Supply Functions, op. cit.*, p. 166.

[13] The typical farm sizes selected do not correspond exactly to the means of the Census size classifications used in table 2. Thus, for example, typical farms of 1,600, 800, 480 and 160 acres were used to represent size groups

(Footnote 13 continued to page 8.)

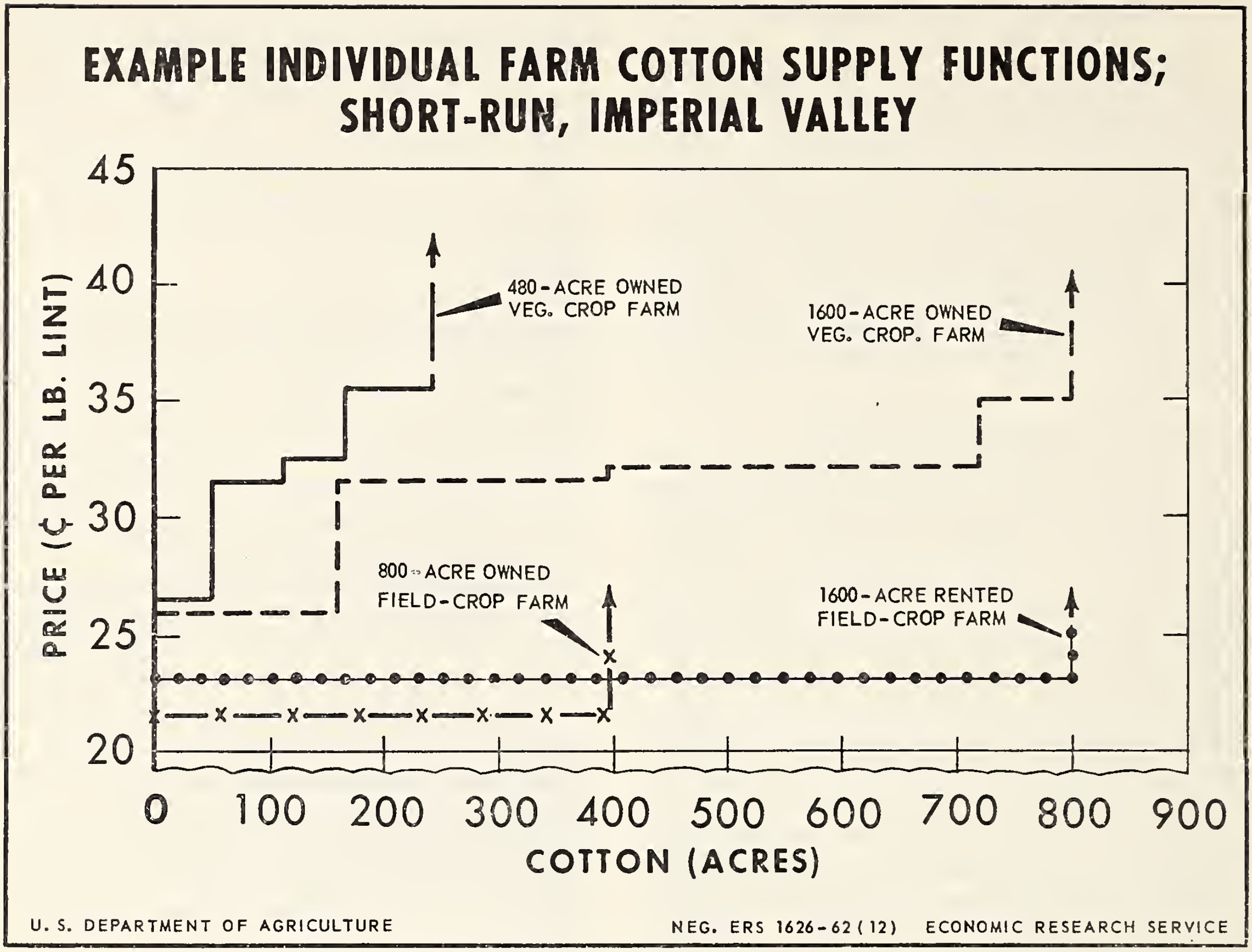

Figure 1.

gate functions show the expected shift to the right as the length of run increases. In the long run, the major emphasis in the analysis is on the supply "shifters" and on structural change in the industry. Major factors causing the supply function to shift to the right are (1) more land available for cotton production, (2) improved technology resulting in higher cotton yields per acre and (3) shifts in the size distribution of farms.

A comparison of the 1960 cotton price and production in Imperial Valley with the short-run supply function suggests that without controls farmers would profitably produce considerably more at the 1960 price, or the same 1960 quantity at lower prices. While the "normative" (what farmers *should* do to maximize profits) short-run function in figure 2 undoubtedly deviates from the "predictive" (what they *would* do), it suggests the direction of immediate adjustment to different levels of expected prices if controls were removed. As implied earlier, the difference between "normative" and "predictive" is considered to be negligible in the long run, at least relative to the other uncertainties inevitably present in long-range projections.

As cotton price increases, the supply functions in figure 2 eventually reach a physical maximum production and become completely inelastic. The point of zero elasticity, however, is reached at a much lower price in the long run (about 29 cents)

(Footnote 13 concluded.)

5 (>1,000 acres), 4 (500–999 acres), 3 (220–499 acres) and 2 and 1 combined (1–219 acres). Slight adjustments in the number of farms per size group therefore were required to make the number of farms x acreage per farm = total projected acreage per size group.

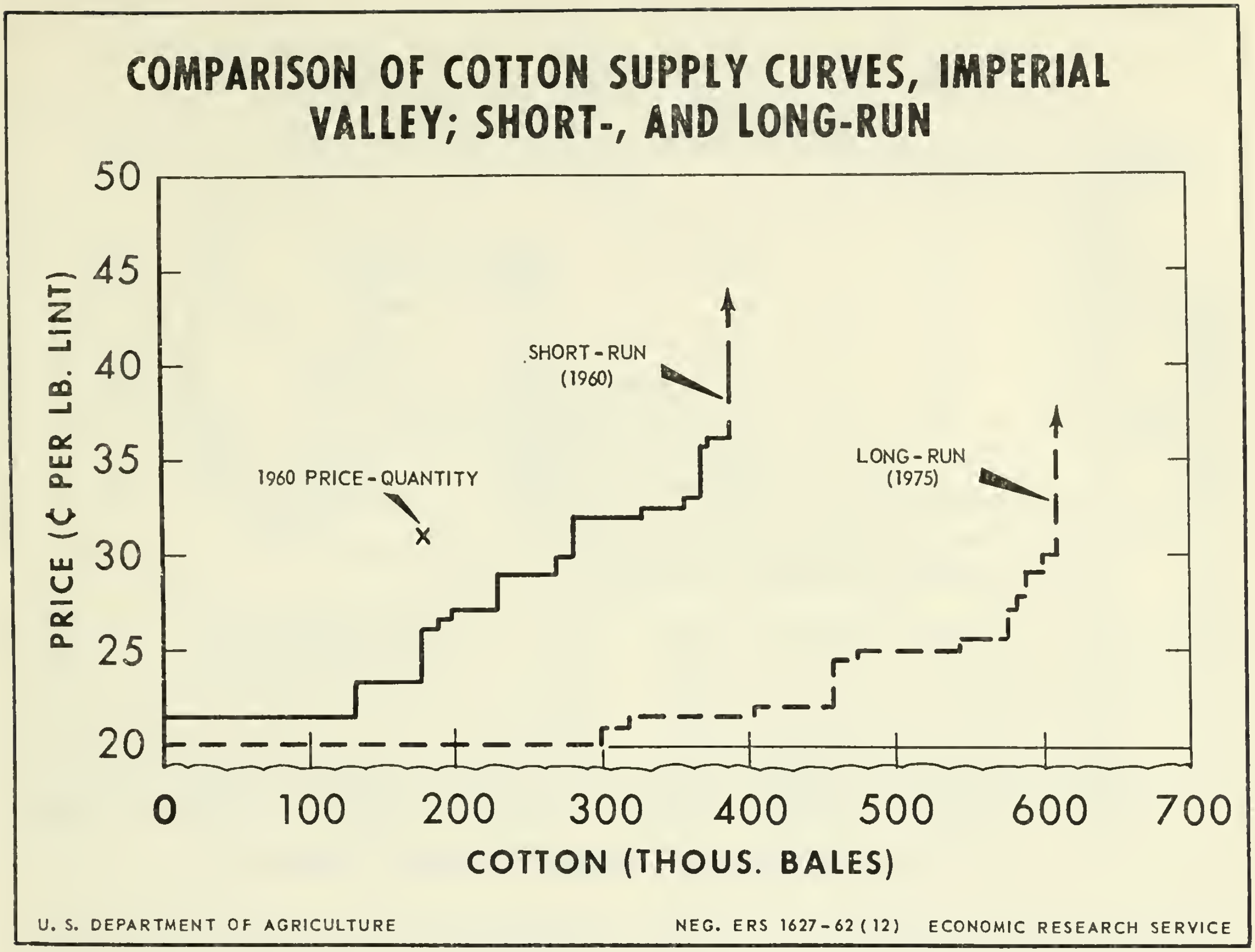

Figure 2.

than in the short run (35–36 cents). The primary reason for this difference stems from the 25-percent wage increase projected for 1975; higher wages reduce the competitive advantage of the labor-intensive vegetable crops, allowing cotton to outcompete them at lower prices. Also, as expected from economic theory, allowing more factors to vary with increasing length of run results in a long-run supply curve which is generally more elastic than the short-run curve.[14] A more complete discussion of long-run supply elasticities is given in the following section.

Effect of Varying Alternative Product Prices

In an attempt to describe more completely the response relationship, the long-run supply function for cotton was examined when alternative crop prices were held constant at prices varying ±30 percent from the original level. Figure 3 summarizes the three supply curves so derived.[15] When alternative crop prices *fall* 30 percent, vegetable crop production becomes relatively unprofitable and field crops dominate, shifting the cotton supply curve to the right. An *increase* in

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[14] Because each function became completely inelastic at some point, this statement is not strictly valid except in comparing the lower stepped portions of the two curves.

[15] In the remainder of the paper, the stepped functions have been "smoothed" free-hand for ease of presentation and computation of elasticities.

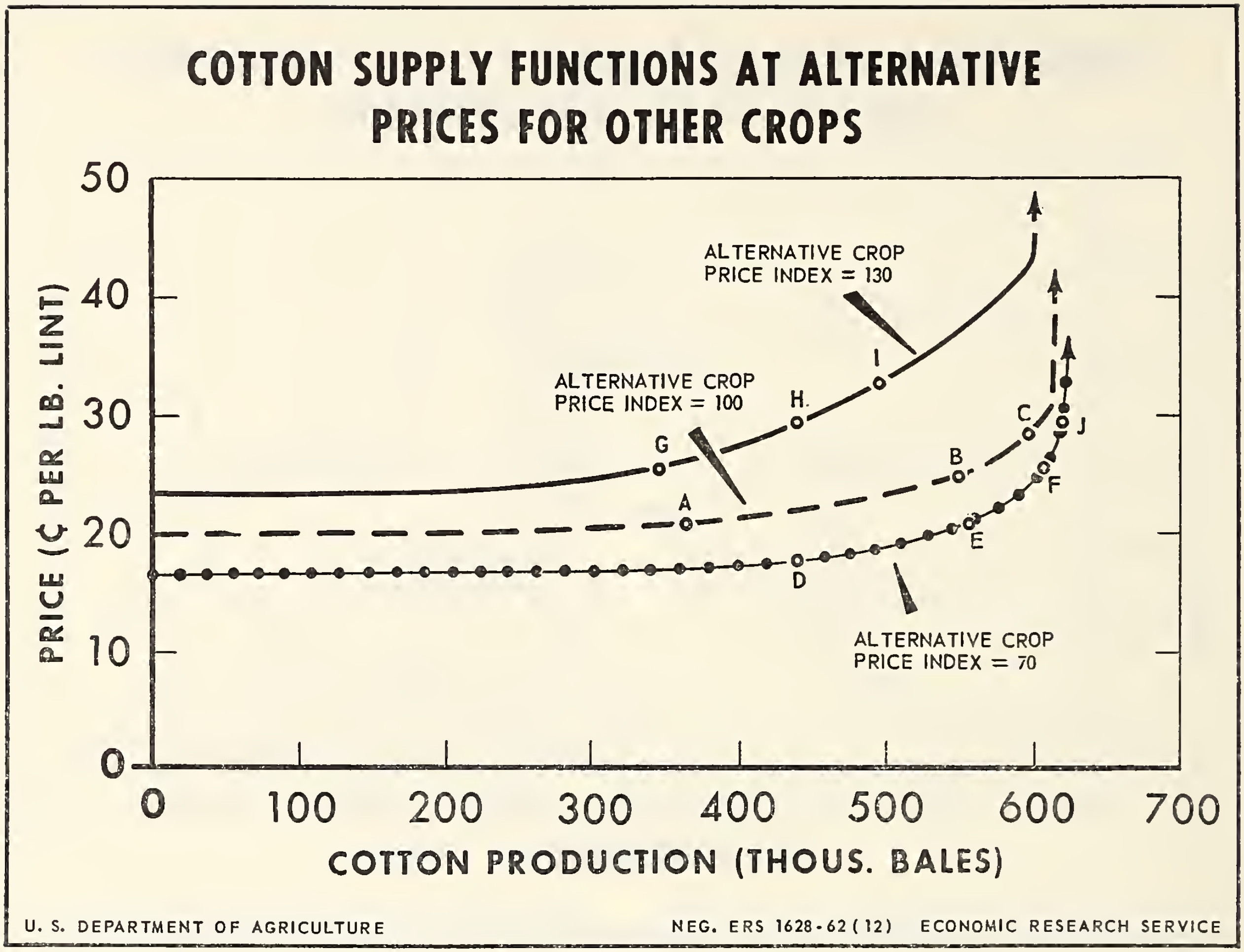

Figure 3.

alternative crop prices of 30 percent greatly increases the profitability of vegetables, forcing the cotton price to rise considerably to be competitive with them, thereby, shifting the supply curve markedly upward.

By synthesizing more "slices" through the price-quantity surface, a rather complete response relationship could be derived, perhaps summarized in equation form as $Q_c=f\ (P_c,\ P_o)$ where $Q_c=$ quantity of cotton, $P_c=$price of cotton and $P_o=$ prices (index) of other crops. It would be interesting to compare the coefficients and elasticities from such a formulation with time series estimates. While this more extensive analysis is not undertaken here, table 3 provides supply elasticities and arc cross-elasticities derived directly from the three curves in figure 3. Within cotton price ranges which are quite possible, these estimates generally appear reasonable compared with prior estimates for other geographic areas. For example, the Imperial Valley analysis indicates that with "other" prices at recent levels (index=100), the price elasticity of supply is 0.4–1.1 in the 25–29 cent cotton price range. Likewise, with alternative prices depressed (index=70), the price elasticity is 0.4–0.8 in the 21–25 cent price range for cotton. Considering the differences in length of run and geographic area, these estimates appear reasonable compared with those derived from time series data by Nerlove[16] (0.20–0.67) for the United States and by Brennan for the Southeast, Delta, and Southwest (0.33, 0.31, and 0.37, respectively).

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[16] Nerlove, Marc, "Estimates of Elasticities of Supply of Selected Agricultural Commodities," *Journal of Farm Economics*, Vol. 38, May 1956, and Brennan, Michael J., "Changes in Cotton Acreage in the Southeast—Implications for Supply Functions," *Journal of Farm Economics*, Vol. 40, November 1958.

TABLE 3.—*Elasticities and cross-elasticities of supply from Imperial Valley, long run*[1]

Cotton lint price (cents per pound)	Index for prices for competing crops (1958–1960=100)	Quantity of cotton produced (1,000 bales)	Point on surface in Figure 3	Elasticity of cotton supply with respect to:	
				Cotton price (supply elasticity)	Competing product prices (cross-elasticity)
21	100	360	A	5.0	
25	100	545	B	1.1	
29	100	600	C	.4	
18	70	450	D	2.2	
21	70	550	E	.8	
25	70	605	F	.4	
25	130	335	G	2.8	
29	130	430	H	1.2	
33	130	495	I	1.0	
21	100–70	360–550	A–E		−1.2
25	130–100	335–545	G–B		−1.8
25	100–70	545–605	B–F		−.3
29	130–100	430–600	H–C		−1.3
29	100–70	600–620	C–J		−.1

[1] Based on figure 3.

However, at lower prices for cotton, table 3 shows extremely high elasticities of supply. Even this result does not seem unexpected for any single relatively homogeneous area, while for a larger aggregate such as the Southwest or United States one would expect different subareas to "come in" to production at different price levels, causing the aggregate elasticity to remain more inelastic over a wider price range.

The cross elasticities in table 3 indicate considerable responsiveness of cotton production to changes in prices of alternative crops, particularly as the alternative prices *rise* relative to cotton prices. Again, these cross-elasticity estimates generally appear to be somewhat higher than those derived by Brennan[17] for the Southeast.

Adjustments of Supply Function for Partial Equilibrium Solution

A valid criticism of the individual farm aggregation approach is that it provides only partial equilibrium solutions. For example, the analysis proceeds as if each farmer maximizes profit based on given assumptions (e.g., fixed resource and product prices). But if all farmers in fact make these profitable adjustments, the resulting aggregate supply relationships may imply quite different resource and product prices from those initially assumed. One of the more critical problems of this type appears to be the price assumptions with respect to products competitive with cotton. Increases in cotton price and production would cause shifts to cotton from competing crops, resulting in reduced supplies and, other things remaining equal, increased prices for the competitive crops. The converse would accompany falling cotton prices and production. Hence, competitive product prices tend to be positively correlated: A rise or fall in cotton price tends to "pull" competing product prices in the same direction. This condition obviously has been violated in the previous analysis, in which competing crop prices were held fixed as the cotton price was varied.

While the above problem is serious on a national level, it is difficult for the analyst in a single area to cope with it until his results have been combined with those of other areas to provide national aggregates suitable for providing revised estimates of competing product prices. For example, in the Imperial Valley analysis, the supplies of competing field crops (primarily alfalfa and feed grains) varied substantially depending on the cotton price. Yet these changes in supply would not be sufficiently large to affect materially the national hay and grain prices (or even the local prices, aside from transportation cost differentials for inshipments from other areas). Obviously, however, if hay and feed grains are major competitive crops with cotton throughout the cotton belt, some adjustments in their prices, and hence, in the aggregate cotton supply function, are in order at the national level.

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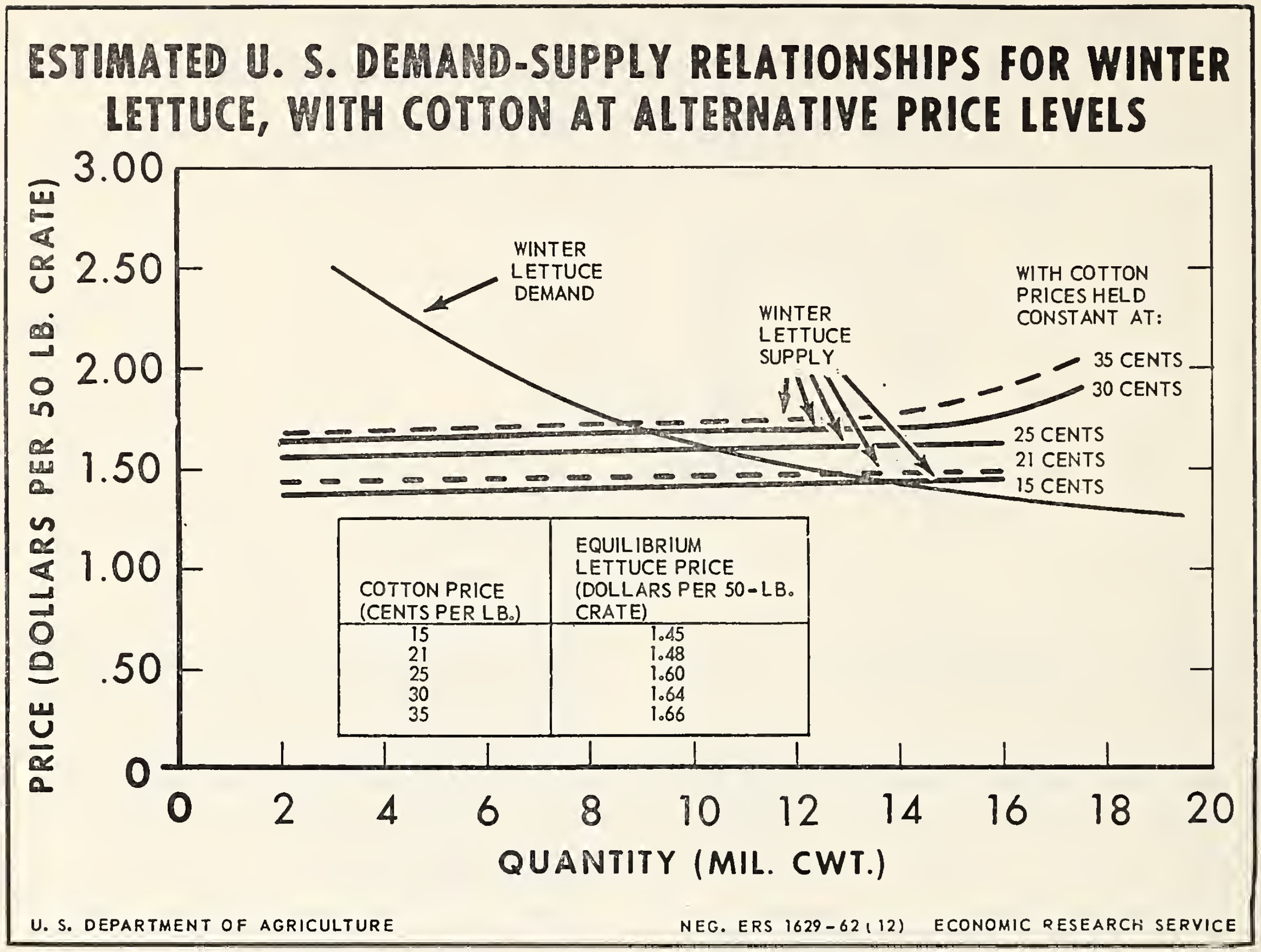
[17] Brennan, ibid., p. 841.



COTTON PRICE (CENTS PER LB.)	EQUILIBRIUM LETTUCE PRICE (DOLLARS PER 50-LB. CRATE)
15	1.45
21	1.48
25	1.60
30	1.64
35	1.66

Figure 4.

A miniature problem of the above type, and an approach to its solution, can be illustrated with the Imperial Valley data. Imperial Valley is the major supplier of winter lettuce in the United States, accounting for 70–75 percent of United States production in recent years. The acreage of winter lettuce in Imperial Valley is relatively important, averaging around 40,000 acres recently, compared to 60,000 acres of cotton. In the earlier linear programming solutions for individual vegetable farms, winter lettuce production varied substantially with changing cotton prices. Yet where Imperial Valley is the dominant winter lettuce supplier, the assumption of a constant lettuce price as lettuce production varies widely is obviously untenable.

A "correction" of the original 1975 cotton supply function for this difficulty includes the following steps: (1) With cotton price set at a given level, determine the lettuce supply functions for the individual farms and for the aggregate; (2) from the intersection of the demand and supply functions for lettuce, determine the "equilibrium" lettuce price; (3) at the "equilibrium" lettuce price and original fixed cotton price, determine the most profitable level of cotton production. In general, the recomputed cotton production-price relationship at the "equilibrium" lettuce price will not coincide with the original relationship; (4) repeat this process at different cotton prices to trace out the revised supply function for cotton.[18]

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[18] Those familiar with linear programming will recognize that the individual farm portion of this analysis could be accomplished more elegantly with variable two-price programming of the individual farms. See Heady, E. O., and Candler, Wilfred, *Linear Programming Methods*, Iowa State College Press, chapter 8.

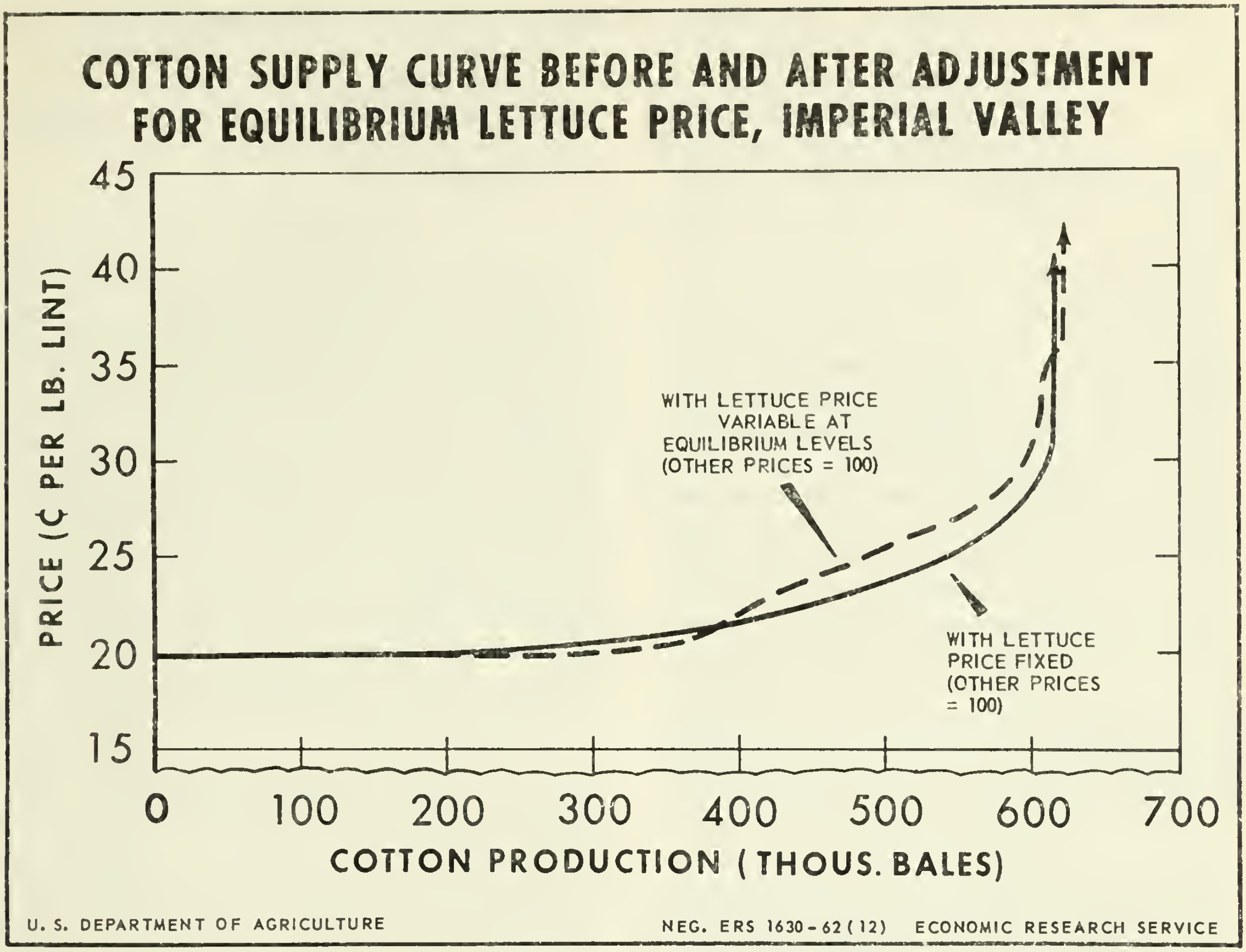

Figure 5.

The empirical results of the above steps are shown graphically in figures 4 and 5. A 1975 aggregate United States demand curve for winter lettuce was derived by first projecting total lettuce consumption (farm weight) at recent prices ($1.50 per carton) to find a single point on the long-run demand curve, then employing the price elasticity of demand estimates of Shuffett to trace out the shape of the demand curve.[19] Shuffett found the demand for lettuce to be extremely elastic (about −2.5), in agreement with other studies also indicating an elastic demand for lettuce. The derived demand curve for winter lettuce is shown in figure 4, along with aggregate industry lettuce supply functions with cotton prices held constant at five discrete levels.[20] The supply curves for lettuce are extremely elastic over the relevant range be-

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[19] Per capita consumption of lettuce was assumed to increase 12 percent from 1960–1975—the same percentage projected for all green-leafy vegetables by Daly. See Daly, Rex F., "The Long-run Demand for Farm Products," *Agricultural Economics Research*, Vol. 8, No. 3, 1956, pp. 73–91. United States population was projected to increase 29 percent to 230 million, resulting in a total consumption increase of 44 percent. The demand equation derived by Shuffett was $X'_1 = 0.0084 - 0.387 X_2 + 0.341 X_3$ when X'=predicted price per crate, X_2=pounds production per capita and X_3 = dollars disposable income per capita (all data in logs). See Shuffett, D. Milton, *The Demand and Price Structure for Selected Vegetables*, U.S. Department of Agriculture, Technical Bul. No. 1105, December 1954, pp. 15–32. Despite a number of weaknesses in data and estimation, recognized by Shuffett, the demand estimates appear to be based on the most complete study of lettuce available and are in reasonable agreement with other estimates of demand elasticities for lettuce.

[20] It was assumed that California will continue to produce about 75 percent of the United States winter lettuce.

(Footnote 20 continued on p. 14.)

cause they tend to "come in" to the individual farm programs at a given price level and immediately expand to the maximum acreage allowed by risk and rotation relationships. Figure 4 also shows the equilibrium lettuce prices corresponding to various cotton prices—the two price series demonstrate the positive correlation hypothesized earlier.

Figure 5 shows the original (other price index = 100) and "corrected" (other price index = 100, except lettuce at equilibrium prices) supply functions for cotton. The general tendency of the correction is to make the supply curve less elastic over the relevant range. That is, at high cotton prices, the price, and supply, of lettuce increases, slightly reducing the cotton acreage and production from those derived originally with the lettuce price fixed (shifts the supply curve to the left). Conversely, low cotton prices are associated with lower lettuce prices, and lower production, increasing the relative profitability and production of cotton compared with the original (shifts the supply curve to the right). The correction in this case is relatively minor because (1) lettuce is a competitive crop with cotton on only part of the cotton producing farms in Imperial Valley, and (2) the lettuce demand and supply curves are extremely elastic. However, the method suggests at least one operational way of helping to correct aggregate results for the partial equilibrium way in which they were derived.

Summary

This paper reports estimates of short- and long-run supply functions for cotton from Imperial Valley, California, assuming removal of Government controls. These results are derived by aggregating "normative" supply functions for typical individual farms. The results derived indicate that, in the short run, farmers would profitably increase production substantially at present prices, or would maintain production at considerably lower cotton prices. In the long run, the supply curve shifts substantially to the right, the major shifters being (1) more land available for cotton production, (2) increased level of technology, and (3) changing farm size distribution toward larger, more efficient farms. The price elasticities of supply derived generally were somewhat higher than previous estimates from time series data. However, as compared with the time series analyses, the present study was based on a smaller, more homogeneous geographic area and a greater length of run. Also, it is shown that the supply function derived generally becomes less elastic when "corrected" for the partial equilibrium way in which it was derived.

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(Footnote 20 concluded.)

The simplifying assumption was made that the remainder of the winter lettuce industry has a supply function of the same elasticity and produces the remaining 25 percent of the market supply throughout the analysis. Hence, the supply functions estimated in figure 4 are for the "industry," not for Imperial Valley alone.

A Polyperiod Model for Estimating the Supply of Milk

By Keith G. Cowling and C. B. Baker

The usual linear programming model for estimating supply functions is a single-period one (*3*).[1] The solution for this period is independent of other periods except as their activities and incomes may be reflected in the resource constraints (*2*). The polyperiod model not only specifies the optimum position toward which the adjustment is presumed to be moving, but also indicates something of the time path and the duration of the adjustment cycle. Methods for developing such a dynamic model are described in this paper. The writers acknowledge the contributions of C. W. Crickman and others in the Farm Production Economics Division, Economic Research Service, who participated in the Regional Lake States Dairy Adjustment Study which provided much of the basic data. Valuable comments also were supplied by William Gossling, J. C. Headley, and Earl Swanson, all of the University of Illinois.

THE POLYPERIOD MODEL presented here is sometimes referred to as a dynamic model (*4*). It defines a long-run plan over time with transition plans specified. For plans in a given solution, prices of activity units are assumed constant over the entire planning period. It may be described as a single model "in which the properties of growth have been imbedded (*9*)." It differs from a single period model by specifying activities separately for each production period and by providing for the transfer of resources from one period to the next to maximize discounted net income over the long run. Thus the optimal solution for any one period depends on the optima in other periods in the model and on the needs for consumption within periods. Viewed as a decision model, the polyperiod model yields a series of decisions over time that are jointly optimal. It also can be viewed as a firm growth model in the limited sense of a growth response permitted by capital accumulation at constant prices. Rates of growth can be compared among alternate prices at which solutions are obtained.[2]

In terms of supply analysis, the quantity of milk (m^t) generated by the polyperiod model in time period t is given by

$$m^t = f(p_m{}^t, p_j{}^t, r_i{}^t, a_{ij}{}^t)$$

Where

$p_m{}^t$ is the price of milk in the t^{th} time period

$p_j{}^t$ is the price on each of the alternative products which compete with milk for the use of resources and includes reservation prices on fixed resources to be allocated within the model in the t^{th} time period

$r_i{}^t$ is the quantity of each resource available to the firm in the t^{th} time period

$a_{ij}{}^t$ is the quantity of each resource required per unit of each product produced in the t^{th} time period.

Thus we can derive a three-dimensional supply function with price, quantity and time on the three axes with one plane defining optimal adjustment to the product price at a specified point in time and another plane defining, for a given price, the optimum growth in supply over time.

The model provides for the transfer of three major types of resources from one period to the next: Cash, dairy cows, and building capacity. The amount of cash transferred from one period to the next depends on the income generated in the first period, the level of income constraint for each period (assumed to cover fixed costs and a minimum level of consumption), and the marginal propensity to consume any income above the level of the income constraint.

It is assumed that investment must come from retained earnings and not from borrowing. The number of dairy cows transferred from one period to the next depends on the number of dairy cows entering the solution in the preceding period, the assumption concerning level of replacement, and the relative profitability of using resources in one period for raising heifers to expand the herd in the following period. The assumption is made that in the aggregate it is not realistic to consider that dairy herds can be expanded by purchasing cows. In a single region, this assumption is violated in reality by interregional transfer of dairy cows.

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[1] Italic numbers in parentheses refer to Literature Cited, page 22.

[2] Candler views the polyperiod model as just another example of parametric programming, each period distinguished by different resource constraints, and suggests the use of parametric procedures to lessen the computational burden. (See (*1*).) However, it is difficult to see how such a procedure could be applied to the model used herein. The solutions for the "n" periods are obtained simultaneously so it is impossible to specify the resource constraints for any but the first period, except where these are fixed over the whole planning horizon.

We note that in a polyperiod model the technique of variable price programming cannot be undertaken as we must specify the price of milk in order to be able to define the relevant coefficient in the income equation for each period.

Results reported below relate to specialized dairy farms in the Illinois part of the Chicago milkshed. Most of the data are from a survey of farms found in randomly selected area segments in a 7-county area surrounding Cook County (fig. 1). The 1959 census reported 7,494 farms in the sample counties. We found about 46 percent of the farms in the sample areas to be "dairy farms." Of these, about two-thirds were specialized in the sense that they had no facilities for livestock other than dairy animals. Resource constraints were defined as for a farm typical of those specialized in dairy production. Relevant activities were limited to those specifically related to dairying.[3] Additional input-output data were derived from cost account records for dairy farms in northern Illinois (*4*, *6*) and from experimental data (*8*).

The Model

The model covers 3 periods, each of 3 years. Each period is represented by the middle year. The 3-year periods represent the time required to expand herd size with retained heifers. Each period has 13 equations, together with a variable number of structural activities. In all three periods, the cropping system is taken as given: 188 acres in a rotation of C–C–O–Cl–Cl.[4] Thus 75 acres of corn are available for grain (at 81 bushels per acre) or for silage (at 14.5 tons per acre) and 75 acres of legume are available for hay (at 2.9 tons per acre) or for pasture (at 180 animal-unit days per acre). Grazing is available for 3,479 animal-unit days from permanent pasture in addition to whatever grazing is available by diverting legume meadow from hay harvest. The 38 acres of oats are assumed to yield 1,121 bushels of corn-equivalent feed.

Constraints

In the first period, the harvest of silage is restricted to available silo capacity. Labor available in winter and summer is restricted to that available on the average farm after substracting out the requirements associated with the fixed part of the farm organization—the crop system (except harvesting requirements) and minor amounts for other livestock. The number of milk cows available is 29, the number observed on the average farm. We assume that for the whole of Period 1 there are just sufficient calves, yearling heifers, and springing heifers to maintain herd size. No expansion is possible until Period 2. Cash is restricted to the supply of liquid and semi-liquid assets after account has been taken of the crop acreage requirement. We require that annual income generated in Period 1 be at least $5,000. This is an arbitrary figure; it is intended to represent a minimum consumption level plus an amount that would cover fixed costs. The dairy activities, the corn-selling activity, and a cash-transfer activity contribute to the fulfillment of this constraint. It is also possible, within the model, to sell cows. Any excess income is siphoned off by the savings activity, 45 percent being used for consumption and the remaining 55 percent contribution to cash in Period 2.[5]

Period 2 repeats the same equations used in Period 1, the only differences being in the definition of the milk-cow equation, the cash equation, and the income equation. Milk cows and cash are transferred from Period 1, cows by way of the dairy activities, cash by way of the savings activity. Thus the initial supply of these resources is shown at zero at the beginning of Period 2. The income requirement assumes a higher value than that in Period 1, because we now include the cash requirements of a fixed acreage of crops, whereas in the previous period the cash requirements were subtracted from an initial cash supply.

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[3] See forthcoming bulletin of the Illinois Agricultural Experiment Station for a report of supply responses for nonspecialized farms in the areas.

[4] This is the rotation that dominated solutions of a single period model wherein an array of rotations comprised alternatives for the use of cropland.

[5] The implied marginal propensity to consume of 0.45 conforms to an estimate made for farm families in the North Central region in (*5*).

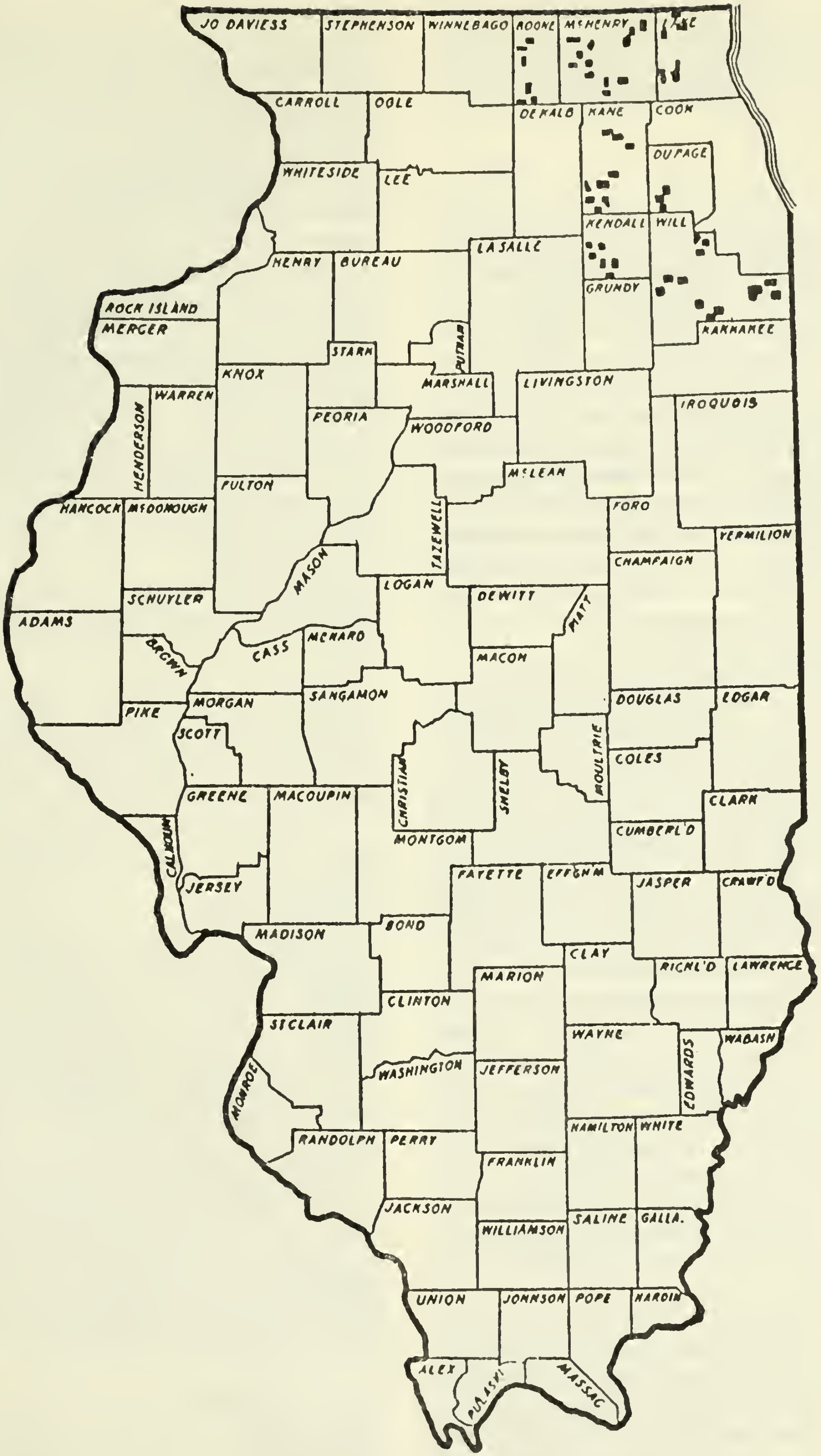

Figure 1. The study area.

Constraints in Period 3 are identical to those in Period 2 except that the capacity constraints (silo and dairy building) are supplemented by whatever capacity expansion took place in the previous period.

Activities

The first four nonbasis activities in Period 1 are harvesting activities that allow corn to be harvested as either grain or silage, and clover as either hay or pasture. Then four dairy activities are defined, differentiated according to varying milk-feed ratios and according to the rate of expansion of dairy cow numbers allowed for in Period 2. One milk-feed ratio is defined at 2.5 : 1 (2.5 pounds of milk to 1.0 pounds of TDN) and allows only for the maintenance of herd size. The next activity is defined at the same milk-feed ratio but allows for the retention of all heifer calves and thus contributes to the maximum expansion of cow numbers. The other two differentiate similarly with respect to herd maintenance or expansion but assume a milk-feed ratio of 4.0 : 1.

We assume that a normal replacement rate of 23 percent will be maintained and that 50 percent of the calves born will be heifers. For every cow retained in a given year, therefore, we have 27 percent of a head for herd expansion. Allowing for 2 percent death loss, we have a quarter of a head per cow per year, available for herd expansion. The maximum rate of herd expansion from the middle year of Period 1 to the middle year of Period 2 is 50 percent per cow retained in the first period. Thus the relevant coefficient for the vectors allowing for expansion is -1.5 in the row representing milk cows in Period 2. A cow-selling vector competes with milk in producing activities for dairy cows because the selling is assumed to take place at the beginning of the period and to contribute cash to the capital supply of the same period. Two vectors are included to allow for labor hiring at $1.00 per hour in both summer and winter. Corn used as dairy feed is valued implicitly at its opportunity cost by including a corn-selling activity.

We transfer excess cash in Period 1 to the income equation of the same period and provide a savings vector to take excess income from Period 1 and transfer 55 percent of it to the cash equation of Period 2. The first eight activities in Period 2 are equivalent to the first eight activities in Period 1 except that the value of each unit of activity is discounted over a longer period (to be discussed below in terms of the objective function). Their total value comprises income in Period 3 rather than in Period 2. Two vectors are present in Periods 2 and 3 that do not appear in Period 1. These involve capacity expansion (silo and dairy) which will not be required for the number of cows present in Period 1. This extra capacity, once constructed, however, will be available for Period 3. A cow-selling vector takes cows from the dairy cow equation for Period 2 and is credited at a discounted value in the criterion equation. In Period 2, cash disposal is credited at zero value in the criterion equation. If cash in Period 2 had a nonzero value in disposal, income from Period 1 could enter the criterion equation directly *for the second time* through the savings vector. The other activities in Period 2 are similar to their counterparts in Period 1.

Except for their unit values, harvesting activities in Period 3 are equivalent to those in the other periods. Only two dairy activities are considered in Period 3, these being defined according to their milk-feed ratios. Both activities allow for replacement only, because expansion of the herd size is not considered beyond the 9-year planning period. Also, cow selling is defined differently to make this activity comparable with the cow-using activities (the milk-producing activities). We ignore the continuance of operations beyond the third period.

Dairy activities in the previous two periods contribute resources to subsequent periods, dairy activities so defined as to allow for replacement, and thus the maintenance of the herd for future periods. On the other hand cow selling serves to reduce the end-of-the-period inventory of dairy cows. To make the activities comparable, the value of a cow sold in the cow-selling vector is adjusted by subtracting the difference between the cost of a replacement cow and the carcass value of a cow. The last activity is an income-dummy vector allowing for accumulation of income in excess of the income constraint for Period 3. This additional vector is necessitated by the absence of a savings vector in the final period.

Objective Function

The farmer's objective is assumed to be the maximization of the present value of a future stream of income. Consistent with this end, we discount (at five percent per year) the value of an activity unit in each period according to the middle year of a particular period. Varying the price of milk entails adjusting not only the C_j values for the dairy activities, but coefficients of the dairy activities in the income equations as well.

Optimal Solutions[6]

The model was solved at selected milk prices over the range from $2.70 per hundredweight to $5.10 per hundredweight. At no price within this range was it profitable to contract herd size in the first period. The number of cows entering the dairy activities was constant at 29 irrespective of the price of milk over the range considered. In Period 2 the maximum herd size was 43. For all milk prices except $2.70, this also was the optimal number. In the third period the optimal number of cows in the dairy activities fell short of the maximum possible, the actual number varying from 39 for the lowest milk price up to 55 for the highest.

The optimal milk-feed ratio proved to be 4.0 : 1 for milk prices of $2.70 and $3.50, with the 2.5 : 1 ratio optimal for all higher prices. This generalization extends to all periods except that in Period 2, for a milk price of $3.50, the optimal feed ratio was 2.5 : 1.

Cows were sold only in Period 2 of the model, with milk priced at $2.70. The Z_j—C_j for cow selling reflects the value of a cow within the farm organization for a particular period *in addition* to its designated selling price, declining with respect to both milk price and time. The cows are most valuable in Period 1 because the present value of their output exceeds that of subsequent periods, and because they provide the only source of later herd expansion.[7] The magnitude of the Z_j—C_j's in Period 1 is of such proportions that we would expect the solution to remain stable over a relatively wide range of lower prices for milk.

In Period 1 cash did not effectively restrict the program. In Periods 2 and 3, however, it proved to be an effective constraint over an intermediate range of milk prices. At low milk prices, it was not profitable to invest in large-scale expansion, whereas, with high milk prices, the additional income generated was more than ample to meet the additional capital requirements. Within the intermediate range of milk prices, the Z_j—C_j's for cash indicated a return of up to 19 cents for an added dollar.

TABLE 1.—*Quantities of milk per year in each of three periods, at selected milk prices: modal farm specialized in milk production, Illinois sector of Chicago milkshed*

Price of milk	Period		
	1	2	3
	Cwt.	*Cwt.*	*Cwt.*
$2. 70	2, 900	3, 764	3, 854
3. 50	2, 900	4, 569	4, 820
3. 90	3, 164	4, 746	5, 692
4. 30	3, 164	4, 746	5, 692
5. 10	3, 164	4, 746	6, 001

Supply Relationships

The quantities of milk generated by the model at specified milk prices are arranged in table 1. To these discrete points, we fit free hand the curves shown in figures 2 and 3. Figure 2 displays supply curves, abscissas of which are milk quantities expected at each of the price levels in the time period indicated. Figure 3 gives the growth over time of milk supply in response to price levels indicated. To the data we also fitted the following cubic function for each period:

$$Y=a+b_1p_y+b_2p^2_y+b_3p^3_y$$

where Y equal quantity of milk, and p_y is the price of milk.

From this fitted function, estimates of the elasticity of supply with respect to price are given in table 2. Either of the curve-fitting procedures may be criticized from two points of view. First, we are fitting discrete points which are not random variables, and, second, we are fitting a continuous function when programming models postulate that the firm is faced with an array of restricting resources which result in a stepped or discontinuous response function. These arguments may be countered by the fact that we need some uniform method for computing elasticities, and that we are concerned with the aggregative response of a population of firms so that the smoothing operation is perhaps not inappropriate.

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[6] All income and output figures quoted in this discussion are on an annual basis.

[7] The values for Z_j—C_j in Period 1 would be reduced, of course, had the model included the alternative of buying cows in Periods 2 and 3.

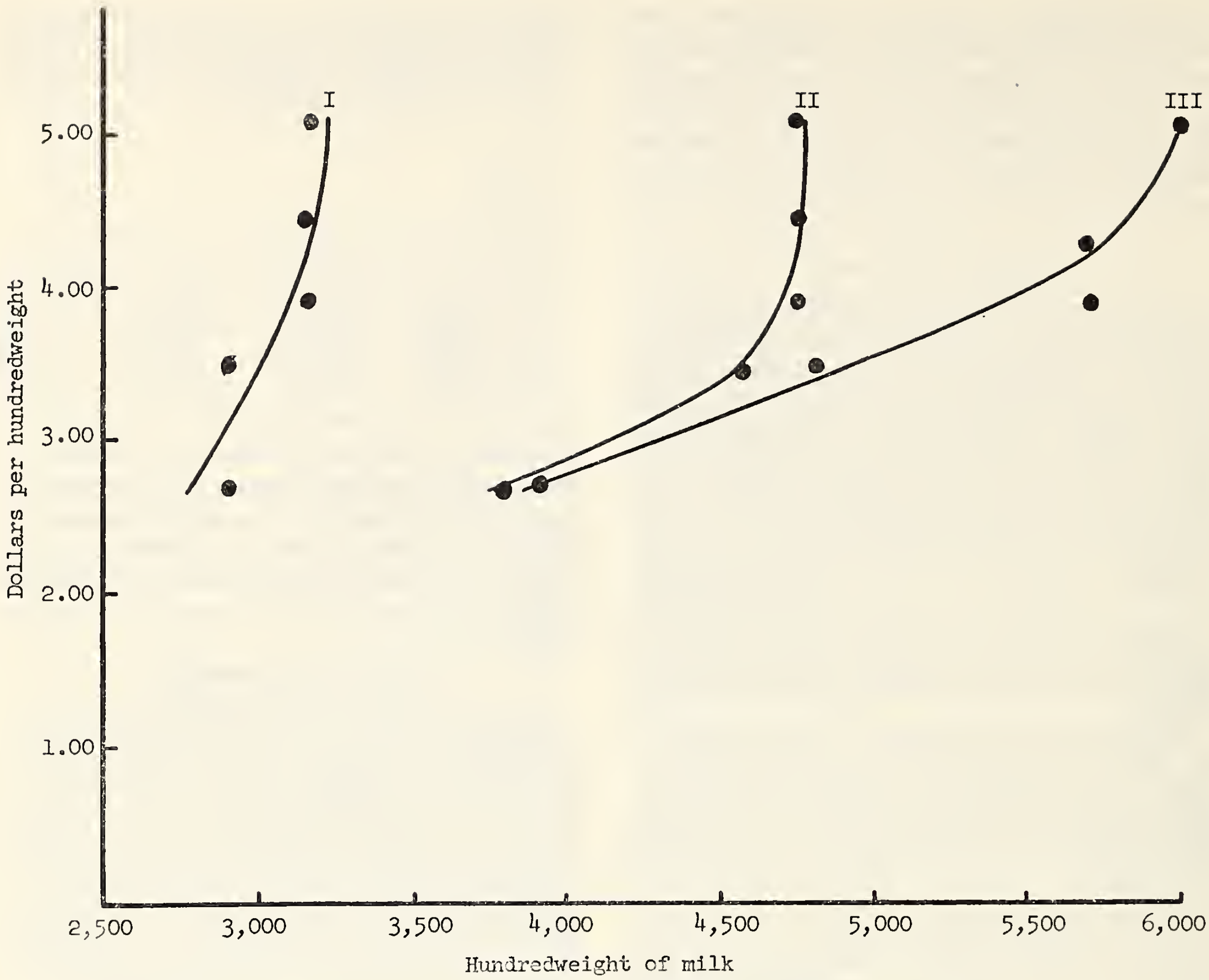

Figure 2. Milk supply response to milk price, by time period for a modal farm.

Table 2.—*Short-run elasticities of milk supply with respect to milk price: modal farm specialized in milk production, Illinois sector of Chicago milkshed*

Price of milk	Period		
	1	2	3
$2.70	0.00	1.15	0.51
3.50	.35	.28	1.22
3.90	.44	.05	.67
4.30	.00	.00	.00
5.10	.00	.00	.00

The elasticities given in table 2 are derived from the cubic functions fitted by least squares procedures and do not necessarily coincide with those implied by the free hand curves, though differences are slight. Given their empiric origin, they are "conventional" in concept. That is, for each year, the elasticity of supply with respect to price is given by

$$\frac{dy}{dp_v}\cdot\frac{p_v}{y}=\frac{1}{y}\,(b_1p_v+2b_2p_v^2+3b_3p_v^3).$$

Thus at $2.70, a zero response would be expected within Period 1 to a 1 percent increase in the price of milk (see table 2). Though high enough to prevent sales to reduce cow numbers below the maximum allowed by the facilities, the price is not high enough to induce changes in rations that would increase milk production. However, in Period 2, a substantial response would occur, given an increase in the price of milk. In this period,

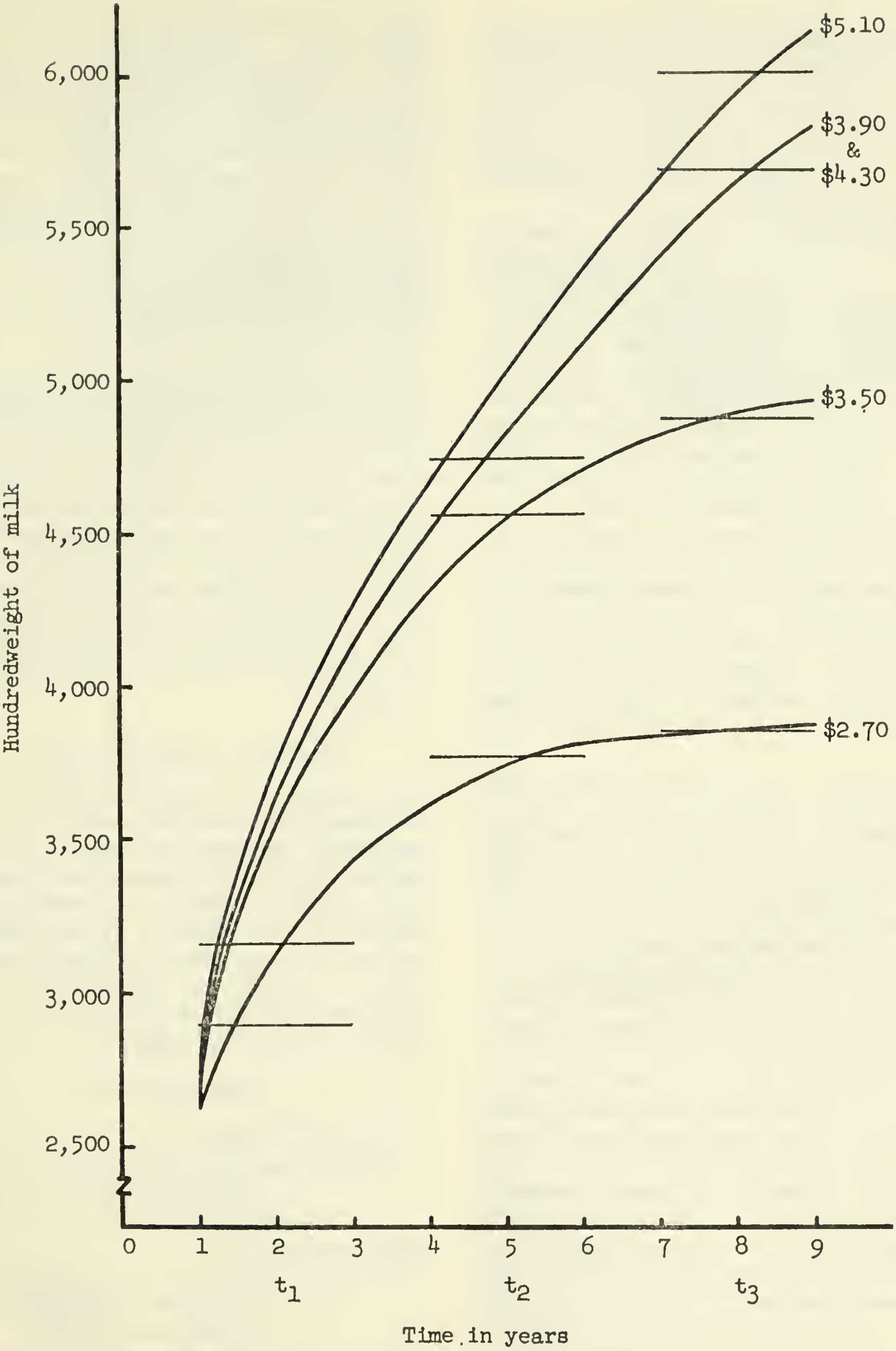

Figure 3. Milk supply response to time, by level of milk price for a modal farm.

investment is allowed to expand facilities and herd size. We noted earlier that at $2.70, the expansion was less than maximum. In Period 3, no further expansion occurred in facilities and the herd also remained constant in size. Thus to a 1 percent change in milk price, at the $2.70 level, the small response reflects change in rations that would be optimal in this period.

In contrast, responses at $3.50 and $3.90 are higher in the first and third periods, especially the third. Although the herd size is constant in Period 1, response in ration changes would be expected at these intermediate prices. (At higher prices, the ration changes already would have been made, thus leaving no alternative for further production response.) In Period 2, the herd was expanded to maximum size permitted by expanded facilities. Thus a relatively small response, from change in rations, would be expected from 1 percent changes in milk price at these levels. On the other hand, in Period 3, the expansion in cow numbers was less than maximum at these prices. Thus herd expansion, as well as change in rations permitted a more substantial response to change in milk price. At higher prices, the responses in each period are restrained by physical facilities, growing at maximum rates permitted by the model.

The polyperiod estimates take explicit account of the maximum expansion possible in terms of cow numbers, the most important element in the long-term supply response of milk, and relate this potential expansion to the specified time period. In the aggregate situation, when it must be considered unrealistic for each herd to expand by buying cows, decisions regarding the level of milking activity and the number of heifers to rear in any one period will affect the capacity to produce in subsequent periods.

On the other hand, single period models consider supply response out of its dynamic content. Such a static analysis considers the purchase or raising of a whole complement of cows in a single period and in aggregate, and gives unreasonably high elasticity estimates. The polyperiod model also is more realistic in that growth is made a function of income after consumption and fixed costs. These assumptions help to explain the generally inelastic estimates derived with the polyperiod model. Also we see that response depends importantly on time, whereas single period models usually assume implicitly a time period sufficiently long to adjust. Finally, we are able not only to associate a response estimate with a specific time period (defined largely by biological phenomena), but also to derive an adjustment path over time.

The polyperiod model goes some way toward the reduction of the aggregation problem by assuming supply response to be less dependent on variables assumed in other models to be exogenous, but which must realistically be considered as endogenous within the aggregate system. More realistic and therefore more useful models must take account of the demand function for milk and the supply function for nonfarm inputs. Another problem area not touched on is that of price uncertainty. In the model considered, expectations are held with certainty, whereas, realistically, they should be considered as stochastic variables.

The model developed was of a very simple form. Defining activities and constraints on a yearly rather than a 3-yearly basis, and incorporating more relevant activities, would add realism. It is clear, however, that it would also add materially to the computational burden which already was substantial even with the simplified model that was applied.

Variants of the Basic Model

No variants of the model actually were run. But it might be useful to consider varying the assumptions regarding consumption and to investigate the effects of technological change over time, in order to estimate the stability of the solutions that were obtained. The computer time required to obtain these solutions severely restricted the number of variations that could be considered, as well as the number of milk prices at which solutions were sought.

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A Reformulation of Certain Structure and Conduct Attributes of Pure Competition

By Norman Townshend-Zellner

Farmers are getting more and more concerned about problems of bargaining power. This is partly because corporations and labor unions in the food marketing business are becoming larger and stronger. We may need new theories, and new concepts, to understand how prices and incomes are actually made. Mr. Townshend-Zellner's paper suggests modifications in the usual assumptions of pure and perfect competition in order to develop a theory that is more realistic, and to open up a field for statistical measurement and analysis.

THIS REPORT suggests three revisions to attributes of structure and conduct of sellers in markets approximating the classical conditions of pure competition. Similar structural relationships logically are applicable to buyers in pure competition. But the emergent conduct on the part of sellers in pure competition—for example, the formation of marketing orders—is of more interest at present. Attention here is therefore focused exclusively on sellers. Differences between the revised concepts suggested in this article and existing ones are shown schematically in figure 1.

1. The fundamental structural attribute among sellers in pure competition is that of very slight (albeit "virtually negligible") interdependence—not independence. This is especially relevant to sellers in agricultural market structures. The competitive model of received theory accepts independence as the relationship among sellers, ignoring the tacit admission of very slight interdependence typically found in the formal statement of assumptions.

2. Three basic *variants* of conduct by purely competitive sellers may emerge in response to the structural attribute of very slight interdependence.[1] Each may be observed empirically.

Passive conduct is identical with the classical conduct of competitive theory. Here the interdependence is ignored. But two forms of transitional conduct, usually neglected in theory because they are exceptional and unstable, are significant for agriculture.

Active, *collusive* conduct exists where the interdependence evokes a collusive response by sellers. This response typically leads to some form of market reorganization.

In some cases *active*, *rivalrous* conduct—the third basic variant—may become a dominant, temporary feature when the interdependence induces a rivalrous response leading to market disorganization or dysfunction.

The character of performance emerging from an industry of sellers in pure competition will vary widely, depending upon the prevailing variant of conduct. The notion of *variant* conduct (as opposed to *invariant*, *static* conduct in received theory) gives a dynamic dimension to the theory of competitive market structure.

3. The notion of independence among sellers in pure competition (incorporated in most models of pure competition) suffers from the following defect. Independence is identified as an invariant *structural* attribute—that is, as a relationship among sellers—instead of what it really is, namely, a prevalent, indeed typical, mode of seller *conduct* in response to the existing structural attribute of very slight interdependence. To define independence as a fixed structural attribute of pure competition is to close the door, conceptually, to analysis of other important existing variants of seller conduct emerging from pure competition, namely, collusive and rivalrous conduct.

The revisions summarized above were developed largely in response to specific problems in policy and theory which could not be engaged with concepts of market structure derived from the classical competitive model.

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[1] The focal point of research needed concerns what determines the prevailing variant of conduct. It is neither an arbitary choice nor a random occurrence. However, this paper is concerned with the necessary prior task of changing our concept of purely competitive structure to show that more than one variant of emergent conduct is possible.

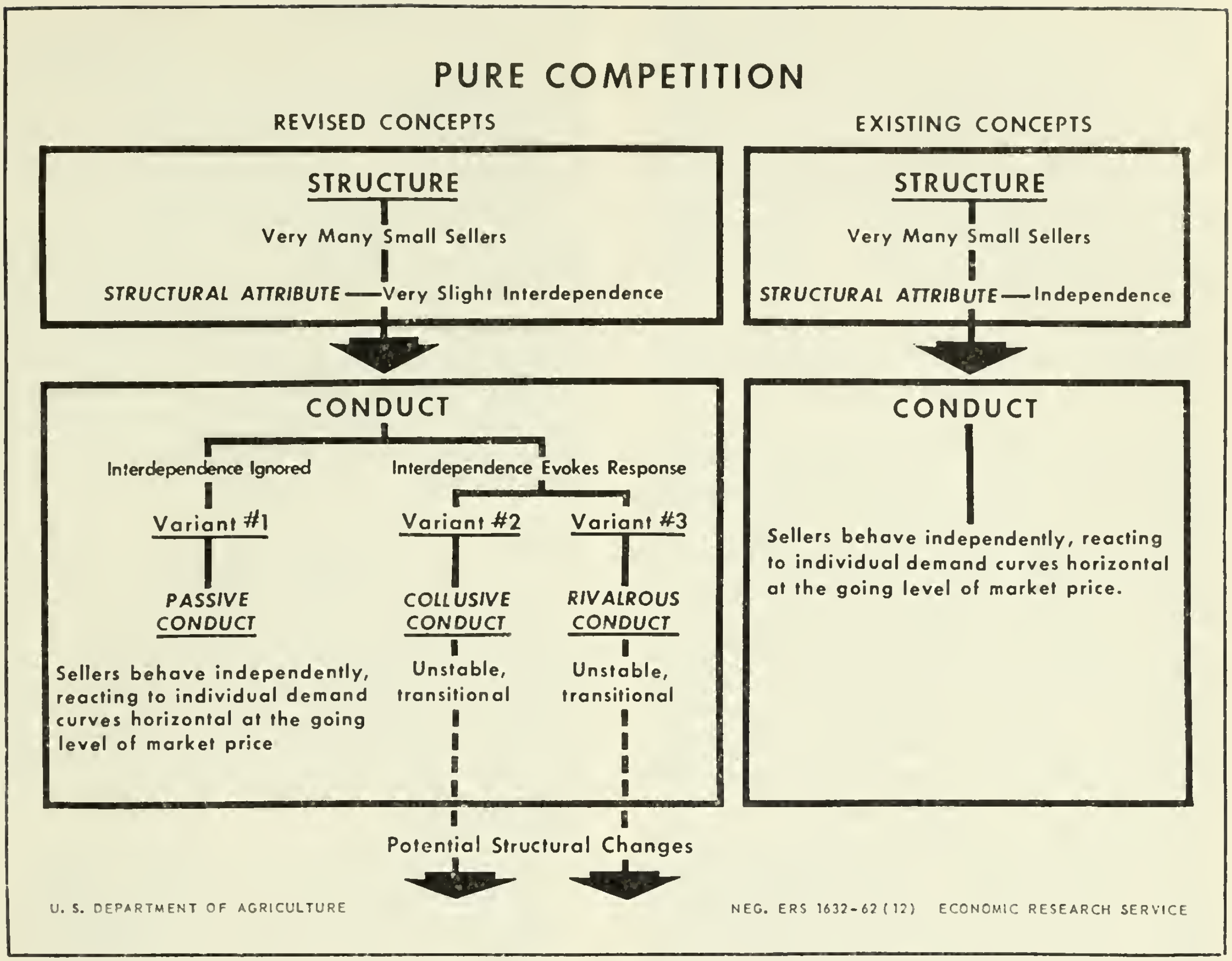
PURE COMPETITION
REVISED CONCEPTS
EXISTING CONCEPTS
STRUCTURE
Very Many Small Sellers
STRUCTURAL ATTRIBUTE—Very Slight Interdependence
STRUCTURE
Very Many Small Sellers
STRUCTURAL ATTRIBUTE—Independence
CONDUCT
Interdependence Ignored
Interdependence Evokes Response
Variant #1
Variant #2
Variant #3
PASSIVE CONDUCT
COLLUSIVE CONDUCT
RIVALROUS CONDUCT
Sellers behave independently, reacting to individual demand curves horizontal at the going level of market price
Unstable, transitional
Unstable, transitional
CONDUCT
Sellers behave independently, reacting to individual demand curves horizontal at the going level of market price.
Potential Structural Changes
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 1632-62 (12) ECONOMIC RESEARCH SERVICE

Figure 1.

Policy-Problems: Farmers' Bargaining Power and Supply Management

Ordinarily, farmers sell their products in market structures approaching pure competition, while the buyers they face operate in market structures much farther removed[2] from purely competitive conditions. This is the root of the problem of farmers' bargaining power. Usually farmers tend to "overproduce" in relation to existing demand, especially under pressures of research and development of new technologies, and given the limited rate of increase in demand. This is the root of the supply-management problem.

Remedies to these problems in many cases have involved control over supply through a variety of devices. But some "self-help" supply-control programs for sellers in pure competition (particularly marketing order programs) transform the sellers' market structure from one approximating pure competition to a structure containing a variety of important noncompetitive, collusive elements. And it is the latter elements which are crucial to the processes of supply-control and any derived impact on bargaining power. If economists are to understand these elements and their implications, to advise farmers to increase their bargaining power and to manage their supplies, the economists must also understand, and appropriately conceptualize, the process by which a purely competitive market on the selling side is dynamically transformed [3] into a market structure significantly *less* competitive. But the classical model of pure competition is essentially static. There exists now no conceptual basis for a dynamic theory of transition out of a purely competitive market structure.[4] Yet, such a theory is applicable directly to our policy problems of bargaining power and supply management. Let us examine this gap in theory more closely in terms of the phenomena left unexplained.

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[2] In the sense of containing important oligopoloid elements, for example, fewness.

Unexplained Phenomena and the Gap in Theory

Consider an agricultural producer industry operating in a structure of substantially pure competition on the selling side, with absence of collusive or rivalrous conduct. Let us call this structure, and emergent seller conduct, "Phenomenon A." Received theory is fairly adequate [5] to explain the observed industry performance. But farmer-sellers in this industry (aware of the advantages of increased bargaining power and management of supplies marketed) are observed suddenly (e.g., as of a certain crop year) to adopt a marketing order and subsequently to operate on the selling side as a type of cartel.

Let us call this new structure and emergent conduct "Phenomenon B." The concepts of received theory also can explain the industry performance resulting within the context of Phenomenon B. But we cannot ignore the phenomenon of the transition, the conduct leading to a structural innovation which moved the seller-industry from a situation approximating pure competition to one of a cartel-type arrangement. Clearly, the really significant variation in industry performance (from purely competitive to cartellistic results) is associated with the *transitional* phenomenon.

But this variation is not formally explained by received theory. Received theory can explain variation in conduct and performance *within* purely competitive and cartellistic structures, but not *between* (in a dynamic sense) such structures. That is, received theory tends to accept as a *given* the existing market structure. Consequently, it cannot explain variation in conduct and performance due to changes produced in market structures by farmer-sellers. Yet these changes are precisely the phenomena that are of current policy-interest.

Theoretically, concepts are needed to *link* (instead of ignore) the conduct and performance of farmer-seller industries in the transitional shift from the structure of pure competition to a structure approximating a cartel. This requires concepts appropriate to a theory of change in market structure as between pure competition and cartel-type behavior. Let us examine in detail why the classical model of pure competition is inappropriate to this task.

Logical Limits on Received Theory Imposed by "Independence"

"Independence" among sellers in pure competition is derived largely from the assumption concerning very large numbers of small sellers. (We are not immediately concerned with the other assumptions.) Received theory would inform sellers in a purely competitive industry that, to paraphrase Bain:

> (1) No one of you ". . . produces a significant proportion of the total market supply."
>
> (2) No one of you ". . . by extending [your] own output to the practical limit or by withdrawing it entirely, can perceptibly influence the market price of [your] product."
>
> (3) Thus, the demand curve for your output ". . . is a horizontal straight line at the level of market price." [6]

That Bain would go on to infer independence (as a structural attribute among sellers) from these assumptions is clear, as he equates the purely competitive seller and the monopolist in this respect:

"Monopoly, in the sense of fullfledged single firm monopoly which can *disregard the rivalrous reactions of other sellers*, is rare in the American economy. *This is also true of the markets at the opposite extreme, with many sellers, all of whom sell a homogeneous [identical] product, often*

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[3] One hypothesis is that this transformation exists in the short-run as a reversible phenomenon, but in the longer-run as a one-way metamorphosis.

[4] Methodologically this has been handled by merely accepting the changed market structure as a new parameter.

[5] This does not deny shortcomings in received theory, e.g., the pervasive problem of price-determination as between purely competitive sellers and oligopsonistic buyers.

[6] Bain, Joe S. *Pricing, Distribution, and Employment. Economics of an Enterprise System*, New York. Henry Holt & Co., 1948, pp. 47–48.

characterized as markets in pure competition."[7] (Emphasis added.)

Thus, received theory travels the route from very large numbers of small farmer-sellers to a system where each seller exerts no perceptible influence on price, and thence to a model featuring a seller's horizontal demand curve. However, in the process it has committed itself to the notion that independence is an attribute of the structural relationship among sellers.

But there is no denying that farmers as sellers, and especially as *atomistic* sellers, have wished for effective collusion to increase bargaining power (and secure other gains translatable into price) by managing supplies. And the real world is full of examples where farmers in pure competition have made the transition to a collusive group managing supply. But economic theory cannot follow the atomistic farmer-seller in the causal events underlying the transition because conceptually it assigns farmers (once they are there) forever to pure competition. If theory regards farmers in pure competition to be independent *as part of the structural nature of things*, then it cannot explain, or even countenance, collusive tendencies.[8] And the price of escaping from this theoretical dead end might appear to be too high. To give up the independence attribute it might seem that theory would have to accept at least a slightly sloping, instead of a horizontal, seller's demand function in pure competition.

Re-examination of the Independence Concept

Can we admit enough interdependence into a purely competitive situation to explain the movement to a collusive solution, and yet retain the seller's horizontal demand function of competitive theory? Can we have our theoretical cake and eat it too? If, literally, each seller's supply does *not* in any degree affect price—*ceteris paribus* has *zero* effect as opposed to the "virtually negligible," or "imperceptible," effect of theory, then the sum of the zeros for each of the competitive sellers is zero, and collusion and supply management are not profitable.

But, of course, in most agricultural industries approximating pure competition this is not the case empirically. The sum of the "virtually negligible" impacts on price *is* important. Economists (and farmers) are aware that the industry demand curve *is* sloped irrespective of assertions concerning the slope of the individual seller's demand. And the number of sellers in most industries, while large enough to be considered an approximation to pure competition,[9] is short of being infinitely large.

Thus, in the real world farmers are not in fact completely and entirely independent. For a sloping industry demand function implies that the sales of each of a very large number of farmers must have *some* (i.e., greater than zero) effect on the price of each other farmer. This implies that a theory of pure competition whose assumptions are empirically consistent must acknowledge that farmers are to some very *slight* degree *interdependent.* And the totality of all these "imperceptible" impacts of atomistic sellers on price is the counterpart of the sloping industry demand.

Competitive theory, accurately stated, contains this admission, if only by implication. As we have seen, the usual statement of theory is carefully qualified[10] to point out that (emphasis added): sellers ". . . are so many in number and so small that no one of them can *perceptibly* influence the price of the product" (Bain).[11] Or, to quote Stigler:[12] Each firm is " . . . so small relative to the market that it exerts no *perceptible* influence on the prices of the things it buys and sells." Clearly, theory does acknowledge that there is an effect but that crucially it is imperceptible and therefore negligible, e.g., the effect of 1/1000 of the total supply on price. It is the thesis here that this effect, though imperceptible, is not therefore *entirely* negligible. The point is that under certain circumstances the effect is crucial.

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[7] *Ibid.*, p. 47.

[8] Contrast, for example, the following statement with farmers' widespread use of marketing order programs: "Since increases in his (the small seller in pure competition) own output do not tend perceptibly to reduce his price, he does not have the virtual tendency that the monopolist does to restrict his output. Only the rise in his costs with increases in his output will limit his production. In short *he is not in any position to exploit for his own ends the slope of the industry demand curve for the good he produces.*" *Ibid.*, pp. 48–49. (Emphasis added.)

[9] Bain states: "Ordinarily a hundred or more sellers. none of whom produced more than 1 or 2 percent of the market output, would be required to fulfill approximately the condition regarding numbers [in pure competition] . . ." *Ibid.* p. 47.

[10] "Virtually," "imperceptible," and "negligible" are the most commonly encountered qualifiers.

[11] Bain, *op. cit.*, p. 99.

[12] Stigler, George J. *The Theory of Price.* New York. MacMillan, 1946, p. 21.

The farmer-seller acknowledges that his supply does not change price "perceptibly," but he is especially sensitive to the slight impact of the supply of any one of his fellow sellers in terms of its potent effects when aggregated for all of his fellow sellers. Farmers know that price is forced down precisely by the *compounding* of the slight, "imperceptible" effects of individual sellers. That is, they are aware of the very slight, equally "imperceptible" interdependence between individual sellers. They know that the very slight interdependence existing between any seller and any other seller ordinarily can be ignored. Or, perhaps put more accurately, farmers are painfully aware that ordinarily they cannot do anything effectual about the very slight interdependence. But, crucially, they are also very much aware of the significance of this very slight interdependence. Politically, they have sought and gained legislation enabling each farmer to limit his supply with a guarantee that *each* of his atomistic rivals will equally limit supplies. Prior to this legislation the compounding of the "imperceptible effects" of noncooperators' supplies wrecked many a marketing program based on supply limitation.

So far, it would appear that the job of reconciling competitive theory to the notion of interdependence has a foundation on which to build. Theory opens the door slightly by admitting that each farmer-seller does have an "imperceptible" effect on price. However, in the next breath it shuts the door by maintaining the independence concept to derive a *perfectly* horizontal demand curve. Is it necessary to shut the door on interdependence to get the perfectly horizontal demand curve of competitive theory? Is theory paying too high a price?

Reformulation: Interdependence the General Attribute of Structure—Independence a Variant of Conduct

The inability to handle collusive (or rivalrous) activity as these emerge in purely competive markets is the price that theory has paid for independence as a structural attribute. But we can have our assumption of independence and our explanation of the transition to collusion, too, if we are willing to be consistent with the empirics of the case and accept a formulation which makes interdependence the general structural attribute and consigns independence to the role of a major, emergent variant of conduct.

The suggested conceptual revision begins by acknowledging the existence of very slight, albeit negligible, interdependence among sellers in pure competition, and accepting it as the basic structural attribute. The major advantage of this revision, then, is that it does not abstract from (ignore) the slight "discrepancy" which has put existing theory into its current sterile situation vis-à-vis the emergence of collusion and supply management from a purely competitive group of sellers. It already has been shown that slight interdependence is admitted in existing theory, but only by a qualifying phrase, whose logic and implications are never traced out.

But, with the concept of very slight interdependence, can we account (as does existing theory) for the ordinarily observed "independence" of pure competition? This is accomplished by distinguishing conceptually between the notions of structure and emergent conduct. "Very slight interdependence" is a structural attribute and the general structural case. Farmers and sellers in pure competition typically (for example, when there is no move or transition to collusion) choose (implicitly or explicitly) to ignore the very slight interdependence. As sellers then, they behave independently of each other.

"Independence" thus is not a basic structural attribute. It is a mode of seller conduct emerging in response to the structural attribute of very slight interdependence. But suppose, in the competitive situation, that institutional conditions (e.g., enabling legislation) and demand and supply conditions were conducive to collusive activity. Conceivably, another variant of conduct might emerge, namely collusive farmer behavior in response to the slight existing interdependence. Such conduct is dynamic, leading to a structural reorganization of the market. This in fact is typical conduct in every case of instituting a marketing order. Research into this process is one of the most important avenues opened by the reformulation suggested in this paper.

Under the revised concepts, large numbers of atomistic farmers in a market structure usually conduct themselves as though they were independent sellers, i.e., their conduct is passive with respect to the existing slight interdependence. Under this passive-conduct variant it is correct analytically to treat the farmer-seller demand function as horizontal at the going level of market price. In this sense, independent behavior is reconciled with a structure of very slight interdependence. But, using this revised concept, we can also handle the observed phenomena of the collusive-conduct variant.

In the early steps of forming a marketing order a voluntary working committee of atomistic sellers is formed. Here the emergent conduct of purely competitive sellers is *active* with respect to the very slight interdependence. Instead of independent conduct emerging as a passive response to the slight interdependence, we now have conduct based essentially on recognition of, and reaction to, the slight interdependence. Similarly, under extremely depressed demand, falling prices, and heavy supplies, atomistic sellers might actively respond to the slight interdependence by rivalrous conduct, leading to market disorganization, often termed "demoralization."

Implications

The reformulation suggested in this paper shows that the independence of purely competitive sellers in received theory is actually a special case of competitive market conduct and not a general attribute of competitive market structure. Thus, it enables us to break out, conceptually, into full treatment of all the conduct variants (in addition to the one handled by existing theory) inherent in the purely competitive structure of very slight interdependence. It is basically because of this enlarged capability that the revised concepts may be analytically more fruitful than those of existing theory. The fundamental implication of this paper is that the concepts developed enable us to embark on the dynamic analysis of collusive and rivalrous conduct by farmer-sellers in purely competitive markets. The analysis itself remains as a future challenge to economists.

Book Reviews

The Care of the Earth; A History of Husbandry

By Russell Lord. Thomas Nelson & Sons, New York. 480 pages. 1962. $7.50.

MOST PEOPLE who review Russell Lord's latest book will no doubt do so in terms describing "grace of style" and "depth of feeling." I have known Russell for nearly 40 years and have long been aware of these two fine qualities in his writing. He is an artist but he is also an agricultural philosopher and historian. Until he founded "Friends of the Land" and its organ *The Land*, I had not been fully aware of the depth of his agricultural philosophy.

Lord's *History of Husbandry* is written for the general public but is badly needed by both the scientific and economic technicians. They tend to suffer (and benefit) from overexactitude and thus lose the broad sweep of the millennia. Lord in spite of a few minor and forgivable inexactitudes, furnishes perspective. In the white heat of his insights Russell has always been prone to let the "greater" override the "lesser," sometimes not doing the "lesser" accounts justice. When I was Secretary of Agriculture and not as tolerant of minor mistakes as I am now, Russ once said to a mutual friend, "The Secretary is sure hell on commas." As time has gone on, I have come to realize that Russell Lord's minor faults are infinitely outweighed by his firm grasp on a magnificent overall picture of the land as it has made man over the past million years and man as he has destroyed land over the past 10,000 years. His skill is almost like that of the unknown scribes who reduced the age-long traditions of the Hebrews to writing in the book of Genesis.

In Russell Lord's cosmology, present-day man appears as a tiny dot bobbing about on the vast ocean of previously elapsed time. However, Lord tries to find a key to it all which will give present-day man wisdom to do justice to the soil and to his suddenly expanded world. Lord like so many of us is torn between man's tininess and his enormous potentiality. Like most of us he is fully aware of the vast but uneven impact of science in the West and in Russia on the underdeveloped peoples. The author sees the age of soil and resource exploitation coming to an end, not soon but eventually. He sees a vast expansion in man's capacity to realize the unity of life. This is a man of faith speaking, not a man of science.

One concrete basis for Lord's faith is what he has observed about Puerto Rico from the time he first went there with Rex Tugwell in 1941 until today. Giving Tugwell, Roosevelt, and Muñoz-Marín full credit, he realizes that great as has been the advance of the past 20 years, the industry created by favorable tax laws has not been enough. Nor has it been enough that there are a few favorable places to which Puerto Ricans can migrate in the USA. True, in terms of dollars the income per capita in Puerto Rico is now five times what it was 20 years ago and today nearly all the people can read and write whereas 20 years ago only one-half could do so. Lord is a sufficient realist to be aware of the backward places both in Puerto Rico and Harlem. We have moved upward in Puerto Rico and that is enough for Lord. He does not expect any ultimate answers, only movement in the right direction as he quotes Liberty Hyde Bailey, "The upward signs of life and growth are greater than the signs of death."

Lord above all is enormously impressed with the growth of ideas through the ages. He sees ancient man whether in Mesopotamia, Peru, Java, India, or China relating himself to the soil. In some cases he sees a balance struck between man and his environment which lasts for many hundreds of years. In other cases the lack of balance, the failure to replenish the soil, caused continued migration or the downfall of mighty civilizations. History again and again relates the downfall of the exploiters and conquerors who did not understand "land."

Nowhere have I seen in one book such a rich and thought-provoking assemblage of quotations from the sages of the past 2,500 years. Out of it all Russell Lord evokes a deep feeling for the unity of life as it is properly related to the ever-renewing earth.

When Lord comes to the agriculture of the USA during the past century his tempo changes completely. Here the essence of his contention is found on page 265:

"The present American experiment in developing flexible forms of economic and social democracy, striking midway courses between individual and public enterprise, seeking reconciliations between local, state, regional, and Federal mandate and decision, is certainly a far more daring and radical departure from pre-ancient modes of government than communism is, or probably ever will be." He goes on to define communism as a "concept of absolute government older than the pyramids, older than the stone gods of the Incas."

Lord thinks our system radical and the Russian system reactionary in an extreme degree. He then proceeds to put agriculture, the soil, and all the civilization built thereon, on a political basis, claiming that it was never more so than right here and now in the USA. I find it hard to go along with Lord on this unless he defines politics in far broader terms than "Conservative" or "Radical"—"Republican" or "Democrat."

He quotes Einstein as saying, "From now on, Mr. Wilson, it is a race between education and catastrophe." Then he goes on to say, "The time may come, even within the lifetime of those now young, when the excessively nationalistic passions and programs born of war in this and other lands will be reshaped into more definite and durable instruments of progress."

In conclusion, I may say I am glad that Russell, on pages 421 and 422, honors me by quoting from a 1959 talk I gave in Washington, D.C. Curiously enough in that talk I referred to the DNA—deoxyribonucleic acid is the chemical that passes on hereditary information from one generation to the next. DNA has recently been given Nobel Prize publicity. In my talk, which Russell quotes, I referred to DNA in the following way: "No matter how much we may learn about DNA and the control of heredity, I say the mystery of life will grow greater, not less, as our knowledge expands. . . . May we find the wisdom and knowledge to reconcile our past with our ever more rapidly changing future."

Russell Lord strives in his book to find the answer to my prayer.

Henry A. Wallace

Capital in the American Economy—Its Formation and Financing.

By Simon Kuznets, assisted by Elizabeth Jenks. Princeton University Press. 664 pages. 1961. $12.

TWELVE YEARS AGO the National Bureau of Economic Research undertook a major study of capital formation and financing in the United States. The guiding thought was this: Human welfare takes more material output, and more output takes more capital goods to produce it. Additions to the capital stock take corresponding savings out of current income. Such investment of saving is necessary if the individual quest for future security through financial savings is to be realized—i.e., if financial savings for retirement, etc., is to be later converted into goods and services without depriving others. Financial institutions channel savings into investment. Changes in such institutions over the long term are adaptations to changing needs. In this setting, the National Bureau has taken as its task to describe the changes in capital formation and financing and assign reasons.

Professor Kuznets' monumental effort is the seventh and last volume in the project. Separate volumes by different authors covering residential real estate; agriculture; transportation; communications, and public utilities; manufacturing and milling; governments; and financial intermediaries were published from 1956 through 1961. The present work draws on major findings of these works and brings them into a framework of consistent countrywise estimates, and interprets the meaning.

The book is divided into 10 chapters covering total capital formation, 1869–1955; trends in the structure of capital formation; trends in financing of capital formation; and 20-year swings in the long-term trends. A separate chapter summarizes the major findings and another interprets the findings, in a provisional way, for the future. The statistical appendixes cover 172 pages.

Only a few major points rather than a summary can be given.

1. From almost any angle the growth in total stock of capital (defined as construction, producers durables, business inventories, and net changes in foreign claims) has been impressive. The 1955 net capital stock was 15 to 16 times its

1869 level. The per capita increase was about fourfold. Since 1869 growth in capital formation held to about 20 percent of gross national product in current prices. In constant prices a slight downward trend occurred. Net capital formation in current prices declined from about 13 percent of net national product in 1869–88 to 9 percent in 1946–55. In constant prices the decline was from 15 to 7 percent.

This retardation reflects mainly the slowdown of the growth of gross capital formation attending the slowdown of population growth, and the increased importance of depreciable capital and, particularly, short-lived capital.

Kuznets emphasizes that capital consumption, the difference between gross and net capital formation, reflects economic obsolescence more than physical wear. Hence, zero net capital formation would not signify failure to add to productive capacity. Gross capital formation is the most inclusive measure of additions to productive capacity.

2. What accounts for the impressive growth of capital? The growth of population and labor force can only account for a minor part. (However, *retardation* of population growth could have caused, indirectly, *retardation* in capital growth by retarding increased specialization of production, increased productivity, and capital formation. This aside is typical of many stimulating comments Kuznets inserts throughout.) The main determinant of capital growth is the growth of product: While the product of one period depends on capital formation in the previous period, the latter depends on the product of a still earlier period out of which the required savings took place.

With this, the author examines growth of capital and the growth of output. The increase in real net national product per capita tripled over six decades—an unparalleled achievement—and reveals no clear evidence of any retardation in the the rate of increase. On the other hand, the growth rate of capital per person turned sharply downward after the 1920's. The comparative growth rates is expressed as a decline in the net capital-output ratio.

3. How explain this decline in the relative importance of capital since the 1920's? While it is not a firm inference from the record, Kuznets says that

> ". . . the explanation of the levels of and trends in capital formation in this country is to be sought in the saving process—in the factors that govern the supply of savings rather than the demand for capital funds. It is in the economic and social constraints on the savings contribution of governments and of private corporations, and in the factors that govern the consumption and savings patterns of individuals—the main source of savings—that we may find the basis for a theory that would cogently account for the levels of and trends in at least the *proportion* of capital formation to national product." (pp. 110–111)

This is a bold thought and it divides Professor Kuznets from others who hold that the principal limitations on capital formation is in the demand for capital. It is a welcome intellectual thrust and should stimulate thinking about the entire issue, including Kuznets' cogent ideas on determinants of the level of savings.

4. Extended analysis is given to financing capital formation since 1900. However, the shortness of the period covered, in the light of major instabilities, and the complexity of financial transactions are handicaps to analysis. Yet definite trends in external and internal financing are discerned and rationalized. The increasing importance of financial intermediaries in the scheme of things is described following Goldsmith's detailed volume on the subject.

The student of finance will find the many statistical findings useful and still be sympathetic with the author's dissatisfaction with what can be shown with existing data. This reviewer would like to see the time that empirical analyses of financing investment could be cast into a framework wherein the whole complex of financial claims that allocate equity and define enterprise positions (and not just corporate shares) are considered. Equity claims and not debt claims are the chief determinants of production and capital formation.

A final point deserves mention. Some of the restraint on capital formation and savings in recent decades, discovered by the author, probably arises out of a classification procedure. There has been a marked shift in the locus of capital from producer sectors to household sectors—e.g., from buses to autos, from laundries to home washers and dryers, from theaters to television, etc.

The author's warrant for excluding these in national capital formation and savings, is that they reflect consumer activity. Consistent with this view, estimates of household production of services are not included in national income (except for the services of dwellings).

The capital-output ratio for the household as a producer undoubtedly is much higher than the capital-output ratio of commercial producers of the corresponding services—since the household is a very "inefficient" plant for such purposes. But this so-called inefficiency also reflects the fact that people do more savings in the form of durable articles than in financial claims (if one could anticipate his retirement needs correctly, he might do even more of his savings for retirement in durable articles). To interpret the welfare implications of these shifts requires a fuller understanding than we have of the economics of the household in the context of uncounted social costs of living, commuting, and working in congested urban centers.

Professor Kuznets probably is quite aware of such gaps and limitations. Caution abounds throughout his admirable book and his own assessment of it is summarized at one point as follows:

> ". . . while we hope that it advances our knowledge a notch, its contribution can be tested only when its results have been absorbed and revised in a more extensive framework in which they will find their proper niche as well as eventual oblivion in the loss of their identity." (p. 14)

Allen B. Paul

The Real National Income of Soviet Russia Since 1928

By Abram Bergson. Harvard University Press, Cambridge, Massachusetts. 472 pages. 1961. $8.75.

THIS is an important book—and an irritating one. It is important because it provides long awaited measures of Soviet economic growth from 1928, the start of the First Five-Year Plan, to 1955 when the Fifth Five-Year Plan ended. It is irritating because poor organization and heavy, repetitive prose make it very hard to read.

Economic intelligence work of a high order is necessary to penetrate the smoke curtain of official statistics released—or not released—by the Soviet government. Professor Bergson, a leading practitioner of this art, is associated with the Russian Research Center at Harvard University and also with the Economics Division of the RAND Corporation. His latest work is the culmination of nearly 20 years of research to which many persons contributed.

National income releases by the Soviet government have been limited in scope, usually confined to over-all aggregates, and sometimes given only as percentage changes. Soviet concepts have also been influenced by the artificial Marxian distinction between productive and unproductive activity. Under the circumstances, the "Sovietologists" in this country have felt rather strongly that the construction of social accounts for Soviet Russia was much too important a job to be left entirely to Soviet statisticians.

We share this opinion. But it is harder to accept the bickering that has ensued among multifarious experts—and that is again evident in this book. It is almost as if sluggish growth and excess capacity in this country have provided a surplus of resources to be used in measuring the more efficient performance of another economy. Let us hope that our own performance will soon belie such impressions.

This study is actually concerned with the real gross national product of Soviet Russia, not its real national income, so a better title might have been "Soviet GNP in Constant Prices, 1928–55". GNP estimates for 1928, 1937, 1940, 1944, 1950, and 1955 were developed in constant ruble prices, using alternative price weights for several widely separated years so as to insure that the analysis would not be vitiated by the index number problem.

This was a tremendous job of developing estimates and analyzing the results. Bergson gives credit in the preface to 22 different persons for important contributions, some of which have already been published as studies of significance in their own right. From the subjects of these separate studies it is evident that the author had some considerable help. But he deserves credit, nevertheless, not alone for the original conception, but also for combining results of the various studies and giving us the first report to express Soviet data in constant ruble values.

Perhaps a simple percentage comparison will help to impress agricultural economists with the many and important implications of this work. Soviet GNP includes an item called "consumption of farm income in kind." It is the same as our "value of farm products consumed directly in farm households," which used to be called "the value of home consumption." This item represented 7½ percent of total Soviet GNP in 1955, down from 30 percent in 1928! By contrast, it was only 2 percent of 1928 GNP in the United States, and has since dropped to a quarter of 1 percent.

Four conclusions are worth mentioning:

(1) The Soviet rate of economic growth in the years under consideration has not been notably or even demonstrably higher than that of the United States in a comparable stage of economic development, namely, the last three decades of the 19th century; but (2) it has been definitely and substantially superior to the rate of economic growth in the United States during recent years; and (3) continued Soviet political control of the rate of saving and investment may prevent the tapering off in the growth rate that might otherwise be expected with greater economic maturity; but (4) even so, and despite Khrushchev's boast, the USSR is not likely to catch up with the USA in total output before 1975 at the earliest.

Such nuggets must be extracted from this mine of information by a process almost hydraulic in character, for lack of a summary is the book's major defect. President Kennedy has doubtless been briefed on comparative economic growth rates for the USA and the USSR. Bergson should have briefed his readers too.

Ernest W. Grove

The Achieving Society

By David C. McClelland. D. Van Nostrand Co., Inc., Princeton, N.J. 512 pages. 1961. $7.95.

THIS BOOK brings together and evaluates massive research investigations of what psychological variables are causally related to economic development. Financed by the Ford Foundation, the project in its various phases was carried out by many workers during the 1950's.

Of the numerous motives investigated, the ones found to be universally important in economic development are called "the need for achievement" and "other directedness"—sensitivity to the sentiments of others as reflected in public opinion, often referred to in this book as the "generalized other"—a concept first made central to social psychology by George Herbert Mead. Of these two motivations, the "need for achievement" is of overriding importance in economic development.

The nature of this need deserves a brief explanation. *What* is needed is assurance that one is increasingly the possessor of personal traits, such as initiative and courageous risk-taking, that make him a superior innovator type of personality, most prized for its own sake and as a valuable agent of the needs and aspirations of men for a greater abundance of want-satisfying goods. But one cannot become a consumer of personal traits, like self-reliant mastery or initiative, by eating these objects as a hungry hound eats meat. Needs for personal qualities can be gratified only through proficient expenditure of one's energies in specific ways of living and making a living that are *interpreted* (whether consciously or unconsciously makes no difference) as gilt-edged evidence of specific character traits. Such evidence may or may not be equated with excellent performance of all employments.

In these terms, what McClelland calls "the need for achievement" is the striving to prove one's personal worth or significance as a go-getting, innovating type of person. Individuals with a high degree of this need seldom get any rest; always they are on the move, even in their fantasies, to achieve concrete evidence of their personal value through increasing proficiency in all their employments, economic or otherwise. If they fail to remember their appointments, leave dust in the corners while sweeping the floor, plow crooked rows, or leave the pasture gate unlocked, they are unhappy. For they interpret such imperfections as prima facie evidence of personal delinquencies that add up to an irritating image of their personal worth or significance to themselves and others. Without this interpretation of proficiency in all employments as valid evidence of personal value or significance, what McClelland calls the "need for achievement" would fall apart like a rope of sand.

In recent years, psychologists have developed methods for obtaining numbers to represent the levels of the achievement motive among individuals and cultural groups. Such numbers are reached through techniques for identifying, coding, and counting achievement images in representative samples of imaginative materials such as individual stories, children's stories, folk tales, verse forms, and art forms, even doodling.

To see if there is a distinct causal relationship between change in the general level of the achievement motive and change in the level of economic development, McClelland and associates carried out measurements of psychological and economic variables in 40 contemporary nations from 1925 through 1950. They also carried out similar measurements in the Ancient Greek civilization from 900 to 100 B.C., in Medieval Spain from 1200 to 1730, and in the English economy from 1500 to 1830. All their findings converged to the same conclusion: A protracted rise in the general level of achievement need precedes a protracted period of economic progress, and a protracted period of economic decline or stagnation is foreshadowed by a persistent decline in the need for achievement. This finding is the first major contribution of the book.

Since the entrepreneur is the main translator of the general national level of achievement motivation into concrete economic performance, McClelland and his associates carefully identified the essential components of entrepreneural behavior such as risk-taking and long-range goals. Then they found through many cross cultural studies that each of its components is tied into a relatively high level of achievement motivation. This is the second major contribution of the book.

For some years it has been known that many life-long motives are acquired in very early years through child-rearing practices of parents. Through many experimental studies as well as cross cultural studies, McClelland and associates identified what specific characteristics of such practices induce a high level of achievement motivation in the oncoming generation, and what characteristics do not. This is the third major contribution of the book.

From these findings emerge the fascinating hypothesis that external conditions, such as political and economic institutions, occupational status, family structure, climate and physical resources, do not directly and automatically generate the achievement motivation that is necessary to exploit them. Instead, they influence economic development only *indirectly* through their effects upon child-rearing practices of parents, which directly determine the level of achievement need in the oncoming generation, which in turn generates economic change. To verify this hypothesis, the author and his associates made many cross cultural and historic investigations. The weight of their evidence strongly tends to confirm the hypothesis, and in so doing casts serious doubt on numerous long-standing explanations of the rise and fall of civilizations. This is the fourth major contribution of the book.

Now and then this reviewer finds himself taking exception to basic conceptualizations in the book, but this in nowise detracts from its outstanding contributions to the large and growing literature on economic development. This is not a book for bedside reading. But if one takes the time and pains to pick it to pieces, assimilate, digest and make its ideas his own, he will greatly enrich his perspectives of economic and cultural change in both present and past civilizations.

John M. Brewster

Land Economics Research

Edited by Joseph Ackerman, Marion Clawson, and Marshall Harris. The Johns Hopkins Press, Baltimore. 270 pages. 1962. $4.00.

WE OWE THE SYMPOSIUM to the Greeks. To them a symposium was literally a banquet at which there was brilliant and entertaining conversation, and free exchange of ideas.

This symposium on land economics comes closer than most contemporary ones to satisfying the ancient criteria as to brillance, wit, and free discussion. The place was Lincoln, Nebraska; the time was June 1961; and the sponsors were the Farm Foundation and Resources for the Future, Inc. The participants were 16 economists representing a cross section of youth and age, enthusiasm and wisdom, experience and training in the field of land economics.

The high level of accomplishment was also due to the careful planning that resulted from a pre-symposium conference of the principal participants some months before the symposium proper.

The 15 chapters are arranged under four headings concerned with scope, theory, procedure, and programs in land economics research. Each chapter was developed by one of the participants and in two instances by two participants jointly.

The focus of the book is on research in land economics with an eye to the future. The evolution from rural to urban phases is traced by M. M. Kelso in his scholarly review of the content and orientation of research in land economics today.

Urban and regional planning and economic growth and development on the world scene are carefully delineated. A chapter by Roy E. Huffman on better utilization of research results considers the responsibility of the researcher for getting his results into use.

The four chapters on theory are among the most stimulating in the book. Walter G. Miller's production theory is well prepared. The sparkling discussion of welfare economics by M. Mason Gaffney may move on too high a plane of sesquipedalianism for many readers. Yet his presentation may help to jar many plodding researchers from their occupational lethargy.

Kenneth H. Parsons' short paper on institutional economics is a cogent statement. But Howard W. Ottoson's parallel columns of similarities and differences between institutional and neoclassical economics deserve the attention of every agricultural economist. He drives home and clinches the point made earlier by John F. Timmons, Kenneth H. Parsons, and others that the different approaches are complementary and not antagonistic.

The chapters on research procedure have merit in emphasizing the need for orderly procedure and methodology. But the close identification of the function of science with the solution of problems may easily fence research into confines that leave too little room for the exercise of free imagination.

It is interesting that it was left for the practical administrator, Harry A. Steele, to point out the inhibiting aspects of the detailed project system and the inflexibilities of research organization: "The attention to basic and pioneering research in recent years is an effort to free the research worker from any inhibiting administrative restraints."

Steele believes research results are most useful if they are available at the strategic time. He stresses the need for continuing support for research organizations that are attuned to long-range programs, yet flexible enough to deal with specific problems as they arise.

For researchers in land economics this book is the most important "landmark" in research appraisal since the 1948 publication of Leonard A. Salter's *A Critical Review of Research in Land Economics*. For agricultural economists in general it is an intellectual banquet of superior rating.

If one might sometimes wish for a larger measure of singular insight and a smaller portion of plural insights, this may be the price of brilliant conversation. In any symposium some loose ends should be left for future conversation pieces.

Ronald L. Mighell

Selected Recent Research Publications in Agricultural Economics Issued by the United States Department of Agriculture and Cooperatively by the State Universities and Colleges[1]

BERNITZ, ALEXANDER. A SURVEY OF CZECHOSLOVAK AGRICULTURE. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign–38, 48 pp., illus. Sept. 1962.

Before World War II, Czechoslovak agriculture was predominantly privately owned. Now about 80 percent of the agricultural land is socialized, either in collectives or state farms. Agricultural production accounts for a little over 10 percent of the national income today compared with about 23 percent prewar. Prewar Czechoslovakia was generally self-sufficient in the production of foodstuffs. At present it is importing bread and feed grains, animal products, and cotton. Sugar, hops, and malt continue to be the principal agricultural exports. Food consumption returned to the prewar level in 1953 due primarily to increased imports and a smaller postwar population. The quality of the diet has also improved slightly but the bulk of the caloric intake is still composed of grain and potatoes.

BERRY, BRIAN J. L. SAMPLING, CODING, AND STORING FLOOD PLAIN DATA. U.S. Dept. Agr., Agr. Handb. 237, 27 pp., illus. Aug. 1962.

The report is concerned with methods of sampling, coding, and storing data relating to the agricultural occupancy of flood plains. It describes a unique field method for punchcard coding and storing of geographic sample data from other sources.

BEVAN, ROLAND, PAWSON, WALTER W., AND BROUGH, OWEN L., JR. A COMPARISON OF CROPPING SYSTEMS FOR THE WASHINGTON-IDAHO PALOUSE AREA. Idaho Agr. Expt. Sta. Bul. 390, 22 pp., illus. Sept. 1962. (Econ. Res. Serv. co-operating.)

The choice of a cropping system is one of the important farm management decisions on Palouse farms. The bulletin was prepared to aid farmers who are comparing possible cropping systems for their farms. It compares seven possible rotations both with and without Government wheat acreage restrictions. The net returns from the several rotations or cropping systems possible for the area will vary by several thousand dollars on a representative farm. Although the bulletin recognizes that farmers may have other goals than maximizing monetary returns, such other goals are ignored in this comparison.

BIEDERMANN, KONRAD, NACK, HERMAN, NEHER, M. B., AND WILHELMY, ODIN, JR. A TECHNICAL-ECONOMIC EVALUATION OF FOUR HIDE-CURING METHODS. U.S. Dept. Agr., Agr. Econ. Rpt. 16, 76 pp., illus. Sept. 1962.

To provide economic data that might help the hide industry maintain and expand markets for their products, the USDA contracted with Batelle Memorial Institute, a private organization, to study and evaluate four hide curing processes. Data were obtained on the costs, labor, and equipment requirements from 21 hide firms curing hides by salt packing, agitated brine curing, brine curing of fleshed hides by the pit method, and agitated brine curing of flesh hides. An important conclusion of this study is that no single curing method is consistently the most efficient and that volume is important to the choice of method.

CHAPMAN, W. FRED, JR. THE ORGANIZATION OF THE WHOLESALE FRUIT AND VEGETABLE MARKET IN SEATTLE-TACOMA, PORTLAND, AND SPOKANE. U.S. Dept. Agri., Mktg. Res. Rpt. 563, 44 pp., illus. Oct. 1962.

Report in a series describing wholesale fruit and vegetable markets in 50 U.S. cities.

CHRISTENSEN, RAYMOND P., AND AINES, RONALD O. ECONOMIC EFFECTS OF ACREAGE CONTROL PROGRAMS IN THE 1950'S. U.S. Dept. Agr., Agr. Econ. Rpt. 18, 51 pp., illus. Oct. 1962.

This report reviews experience during the 1950's with Government programs designed to influence farm production and resource use through establishment of controls on land inputs. It presents information that should help in evaluating similar programs that may be put into effect in the future to help achieve a better balance of farm production with market outlets and to improve returns to resources used in farming.

CHUMNEY, W. T., AND VERMEER, JAMES. COSTS OF CROP PRODUCTION, BY SIZE OF FARM, CENTRAL COTTON-TOBACCO AREA OF NORTH CAROLINA. U.S. Dept. Agr., Agr. Econ. Rpt. 14, 75 pp. Aug. 1962.

Costs per pound of producing tobacco on large farms in the central cotton-tobacco area of North Carolina were 16 percent lower than on small farms in the same area in 1956. For cotton, they were 20 percent lower; for corn, 40 percent lower; and for soybeans, oats, and wheat, 50 percent lower than on small farms. The conclusions were based on a study of 267 farms selected at random.

CONLOGUE, ROBERT M. COSTS OF PROCUREMENT AND ASSEMBLY OF EGGS IN THREE MIDWESTERN STATES. U.S. Dept. Agr., Econ. Res. Serv., ERS–92, 18 pp., illus. Oct. 1962.

This study was designed to find more efficient ways to procure and assemble eggs. Procurement policies and assembly routes of seven Midwestern firms were studied during 1959 and 1960. The report shows that many Midwestern plants can realize savings of 15 to 45 percent in the cost of assembling eggs. These savings would result from a realignment of routes, the use of set-in stations, the payment of price differentials based on volume picked up, and more attention to procurement and assembly problems.

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[1] State publications may be obtained from the issuing agencies of the respective States.

Cooper, Martin R. GETTING STARTED IN FARMING. U.S. Dept. Agr. Farmers' Bul. 1961, 34 pp., illus. Issued 1944, slightly revised Oct. 1962.

The problem of selecting a farm is treated chiefly from the farm-management viewpoint, which considers various influences that have a bearing on farming as a business. Considerations apply primarily to the family-sized farm, in which the home is thought to be as much a part of the farm as are the fields and cows. This bulletin is written for those who know little or nothing about farming and for those with farming experience who want to change their locations. It is intended to help the prospective buyer or renter decide on where he wants to farm, and on how to go about selecting a farm and get started in farming.

Department of Political Economy, University of Edinburgh. NIGERIA: DETERMINANTS OF PROJECTED LEVEL OF DEMAND, SUPPLY, AND IMPORTS OF FARM PRODUCTS IN 1965 AND 1975. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-32, 149 pp., illus. Aug. 1962. (For. Agr. Serv. cooperating.)

By 1965 demand for wheat and/or wheat flour imports may reach levels 25–30 percent above average 1957–60 rate, and by 1975 a doubling of the 1960 level. U.S. share of Nigerian wheat flour imports have been consistently around 60 to 90 percent. Nigerian gross domestic product is likely to advance and by 1965 reach $3,500 millions (at 1957 prices), affording an average income per Nigerian of $85. The tentative estimate for 1975 is $4,500–$5,000 millions with average income of $90–95 per head.

Gavett, Earle E. TRUCK CROP PRODUCTION PRACTICES, BROWARD AND PALM BEACH COUNTIES, FLORIDA. LABOR, POWER, AND MATERIALS BY OPERATION. U.S. Dept. Agr., Econ. Res. Serv., ERS–79, 1962, 31 pp., illus. Oct. 1962.

Different kinds of data are needed for different purposes. Some persons need data on *average* labor, power, and material inputs, while others—particularly county agents and farm budgeters—prefer data for *usual* or *typical* labor, power, and material inputs. The data in this report are presented in such a way as to satisfy both these needs. Data on truck crop production in these two important Florida counties were obtained late in 1959. Information was obtained by personal interviews with 146 farm operators. It presents information on six vegetables grown for the fresh market—snap beans, cabbage, sweet corn, eggplant, sweetpeppers, and squash.

Hoover, Herbert, and Crecink, John C. RURAL NONFARM FAMILIES IN THE CLAY-HILLS OF MISSISSIPPI—INCOMES AND RESOURCES. Miss. Agr. Expt. Sta. Bul. 648, 19 pp. July 1962. (Econ. Res. Serv. cooperating.)

The number of rural nonfarm families in the Clay-Hills area of Mississippi is increasing rapidly while the number of farm families is declining. There are two distinct groups of rural nonfarm families: Those who depend primarily upon off-farm work income for their livelihood, and those who depend primarily upon income transfer payments, rents, and retirement payments for their livelihood. Members of the first group generally are younger, have more formal education, and have larger incomes than the second group. Families with off-farm employment utilized almost three times as much of their available labor as the families depending on nonwork income.

Manchester, Alden C. THE ORGANIZATION OF WHOLESALE FRUIT AND VEGETABLE MARKETS IN DETROIT, ALBANY-SCHENECTADY-TROY, AND WEST VIRGINIA. U.S. Dept. Agr. Mktg. Res. Rpt. 562, 56 pp., illus. Oct. 1962.

Report in a series describing wholesale fruit and vegetable markets in 50 U.S. cities.

Moore, D. S., Tefertiller, K. R., Hughes, W. F., and Rogers, R. H. PRODUCTION REQUIREMENTS, COSTS AND EXPECTED RETURNS FOR CROP ENTERPRISES, HARDLANDS SOILS, HIGH PLAINS OF TEXAS. Tex. Agr. Expt. Sta. MP–601, 57 pp. Aug. 1962. (Econ. Res. Serv. cooperating.)

Purpose of this report is to present information that will be helpful in selecting the most profitable crop enterprises on the hardland soils of the Texas High Plains. Budgets are developed showing potential production levels and costs and returns on a per-acre basis for major crop enterprises at different levels of irrigation. Production levels and costs vary somewhat from farm to farm because of differences in management, climate, irrigation facilities, and size of farm unit.

Podany, Joseph C. THE ORGANIZATION OF THE WHOLESALE FRUIT AND VEGETABLE MARKET IN PHILADELPHIA. U.S. Dept. Agr., Mktg. Res. Rpt. 559, 25 pp., illus. Aug. 1962.

Report in a series describing wholesale fruit and vegetable markets in 50 U.S. cities.

Powell, Jules V., and Reimund, Donn A. THE PECAN SHELLING AND PROCESSING INDUSTRY—PRACTICES, PROBLEMS, PROSPECTS. U.S. Dept. Agr., Agr. Econ. Rpt. 15, 27 pp., illus. Sept. 1962.

The pecan shelling industry has grown from small, largely hand-operated, side-line enterprises to large, highly automated businesses. This report is based on a survey of 74 firms that had net sales of 164 million pounds of pecans in 1960–61. The eight largest firms accounted for 48 percent of the industry sales, and the 37 largest accounted for 90 percent of the industry sales.

Spears, McGehee, and Vining, Dale K. IMPORTANCE OF U.S. FARM EXPORTS TO BALANCE OF PAYMENTS. U.S. Dept. Agr., Econ. Res. Serv., For. Agr. Econ. Rpt. 7, 16 pp., illus. Oct. 1962. (For. Agr. Serv. cooperating.)

Investigates significance of farm exports to the agricultural sector of the U.S. economy, examines the U.S. Government farm export program, and explores the importance of exports to the U.S. balance of international payments. The percentage of farm originating gross product that was exported rose from 12 percent in 1951 to 14 percent in 1960. All farm exports are recorded in the Nation's balance of payments as dollar earnings. In the final year ending June 30, 1961, almost a third of farm exports—$1.5 billion of a total of $4.9 billion—was sold for foreign currencies, donated, or bartered. In fiscal 1961, farm exports produced 15 percent of total farm cash receipts.

Spurlock, Hughes H. TRENDS AND DEVELOPMENTS IN COMMUNIST CHINA'S WORLD TRADE IN FARM PRODUCTS, 1955–60. U.S. Dept. Agr., Econ. Res. Serv., For. Agr. Econ. Rpt. 6, 44 pp. Sept. 1962.

China became a large supplier of farm products sold in world markets during the first 11 years of communist rule. Exported farm products paid for imported machinery and industrial supplies; but by 1961, hunger, malnutrition, and famine forced a cutback in exports and required emergency purchases in food grains, mostly from Canada and Australia. As U.S. and communist China are the world's largest producers of farm products, and both are major exporters, the two areas are competitors in world agricultural markets.

Staff of East European Analysis Branch, Regional Analysis Division. THE AGRICULTURAL SITUATION IN 1961–62 IN THE SOVIET UNION AND OTHER EASTERN EUROPEAN COUNTRIES. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-29, 50 pp. Sept. 1962.

Agricultural output in the Soviet Union and most other European countries declined or fell short of the high official goals last year. Serious food shortages developed in many of these countries. Prices paid to farmers for certain commodities were increased in the Soviet Union and some other Eastern European countries, but prospects for the 1962 harvest make it unlikely that the agricultural and food difficulties will be over soon. Besides the Soviet Union, the report discusses the situation in Poland, Czechoslovakia, East Germany, Hungary, Rumania, Bulgaria, and Yugoslavia.

U.S. Department of Agriculture. RURAL RECREATION—A NEW FAMILY-FARM BUSINESS. REPORT OF TASK FORCE ON INCOME-PRODUCING RECREATION ENTERPRISES ON FARM LAND. U.S. Dept. Agr., 56 pp. Sept. 1962.

This report points to the pressing need for increased recreation areas and facilities. The Nation's farm and ranch land can provide a large part of that need, with income to owners and satisfaction to users. The annual recreation expenditure has increased from less than $4 billion in 1939 to well over $20 billion today, and evidence indicates that this trend will continue. The report discusses the kinds of recreation enterprise adapted to farms and factors affecting development of these facilities.

U.S. Economic Research Service. CHANGES IN FARM PRODUCTION AND EFFICIENCY—A SUMMARY REPORT, 1962. U.S. Dept. Agr., Stat. Bul. 233, 54 pp. Revised Sept. 1962.

This is an annual publication designed to present the major statistical series on farm production, production inputs, and efficiency. The data will help the user to get a historical perspective of what has happened and to measure current changes.

U.S. Economic Research Service. DEVELOPMENTS IN MARKETING SPREADS FOR AGRICULTURAL PRODUCTS IN 1961. REPRINTED FROM HEARINGS BEFORE THE SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS, UNITED STATES SENATE, EIGHTY-SEVENTH CONGRESS, SECOND SESSION. U.S. Dept. Agr., Econ. Res. Serv., ERS–14, 1962, 24 pp., illus. Oct. 1962.

Shows spread between retail and farm prices of food products, farmer's share of retail food dollar, hourly earnings of food marketing employees, total profits of major food processing and distributing firms. Consumer prices for food have risen substantially less than other goods and services in the last 10 years.

Voelker, Stanley W., and Nordbo, Marvin T. STATISTICS ON FERTILIZER CONSUMPTION IN NORTH DAKOTA. N.D. Agr. Expt. Sta. Agr. Econ. Rpt. 25, 49 pp., illus. Sept. 1962. (Econ. Res. Serv. cooperating.)

An important technological development in North Dakota agriculture during the past decade has been the substitution of fertilizer for land and other capital. Consumption of fertilizer increased about tenfold from 1951 to 1961. Different kinds of fertilizer-consumption statistics are available from several sources. This report consolidates data from these sources into a more complete summary of trends in fertilizer usage in North Dakota.

Vosloh, Carl J., Jr. LABOR AND CAPITAL FOR MIXING FORMULA FEEDS. U.S. Dept. Agr., Mktg. Res. Rpt. 564, 28 pp., illus. Oct. 1962.

Second in a group of research studies designed to analyze important phases of the overall feed manufacturing process, this publication is concerned with the heart of the entire process—the mixing center. It provides information on standards for costs, labor, and equipment in two models of mixing centers with capacities of 80 and 200 tons per shift per day. Models were developed from records of feed manufacturers in 34 States.

Statistical Compilations

Crop Reporting Board, U.S. Statis. Rptg. Serv. PRICES RECEIVED BY FARMERS: CITRUS FRUITS, NONCITRUS FRUITS, TREE NUTS, 1944–58; SEASON AVERAGE PRICES OR EQUIVALENT RETURNS BY TYPE OF SALE AND UTILIZATION GROUPS, UNITED STATES AND BY STATES, PARITY PRICES, FRUIT PRICE INDEX. U.S. Dept. Agr., Statis. Bul. 322, 76 pp., illus. Sept. 1962.

U.S. Economic Research Service. SUPPLEMENT FOR 1961 TO CONSUMPTION OF FOOD IN THE UNITED STATES, 1909–52. U.S. Dept. Agr., Agr. Handb. 62, supplement for 1961, 119 pp. Sept. 1962.

Contributors

(Continued from inside front cover)

John M. Brewster of the Farm Production Economics Division, Economic Research Service, has gained a wide reputation for his papers on conflicting beliefs and values involved in policy struggles.

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In a move to step up and streamline information going to U.S. producers and traders about world export markets, the Foreign Agricultural Service has merged two periodicals into a new weekly. The new publication, *Foreign Agriculture*, replaces the 26-year-old monthly of that name and the 43-year-old weekly commodity report, *Foreign Crops and Markets*. The new weekly reports and interprets news of foreign agricultural production and markets, U.S. market development activities abroad, and international government policies and programs affecting U.S. farm trade. Persons or organizations now on mailing lists of *Foreign Agriculture* or *Foreign Crops and Markets* will receive the new magazine. Others may subscribe by writing to the Superintendent of Documents, Government Printing Office, Washington 25, D.C. The subscription rate for *Foreign Agriculture* is $5.50 a year domestic, $8.00 foreign.

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The Farm Index, a new monthly magazine of the Economic Research Service, began publication in October. The magazine reports in nontechnical language the results of the broad research program of the Economic Research Service. Material is grouped according to the special interests of farming, marketing, the foreign market, and the consumer. Regular features are a 2-page digest of the agricultural outlook; a table presenting the latest figures for 50 leading indicators of economic developments in agriculture, marketing, and the general economy; and abstracts of current ERS research publications. You can obtain single copies of *The Farm Index* by writing: Division of Information, Management Operations Staff, U.S. Department of Agriculture, Washington 25, D.C. Subscriptions are available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. for $2 a year domestic, $2.75 foreign.

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